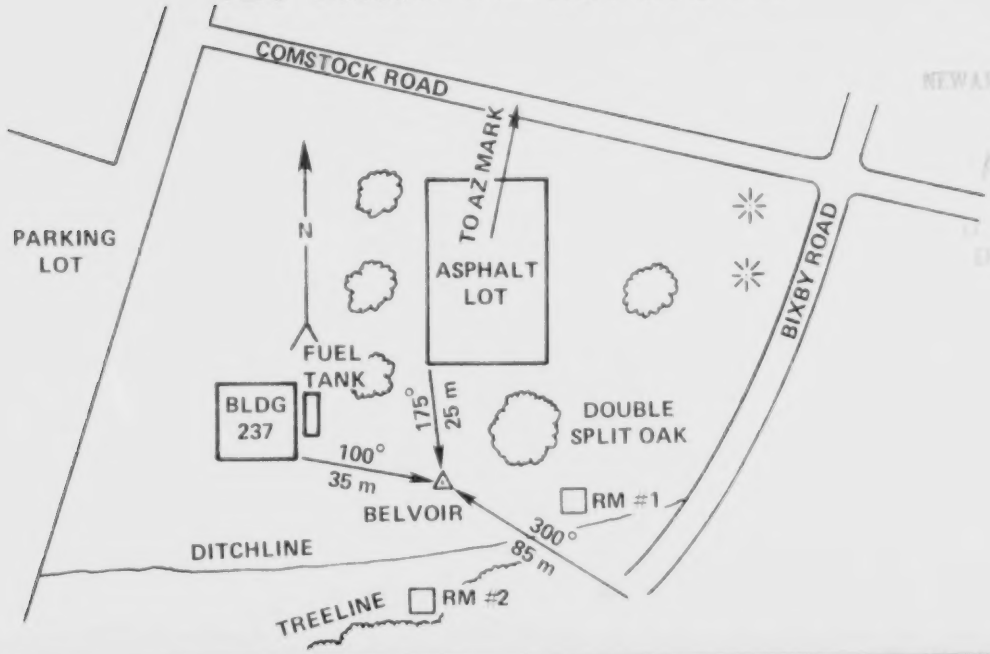
412-051-6781-A

EMPLACE, SKETCH, AND DESCRIBE A PERMANENT SURVEY CONTROL POINT

TEC Lesson 412-051-6781-A



PRODUCED BY
US ARMY ENGINEER SCHOOL
FORT BELVOIR, VIRGINIA 22060

STUDENT/SUPERVISOR INSTRUCTIONS, PRETEST/ POSTTEST, AND ANSWER KEY ARE CONTAINED IN THIS BOOK

MAY 1986

best copy available

D101.6/7:

If you have questions or comments concerning this TEC Lesson, address them to:

Commandant
U.S. Army Engineer School
Attn.: ATZA-TD-I-E*
Fort Belvoir, VA 22060-5291

* Current symbol may be obtained from DA PAM 350-100, Appendix C.

READ THE STUDENT/SUPERVISOR INSTRUCTIONS CAREFULLY. BE SURE YOU UNDERSTAND THEM COMPLETELY BEFORE BEGINNING THE LESSON. PLEASE DO NOT WRITE IN THIS BOOK.

The words "he," "his," and "men," when used in this publication, represent both the masculine and feminine genders, unless otherwise specifically stated.

STUDENT/SUPERVISOR INSTRUCTIONS

TYPE OF LESSON:

- Topographic and Geodetic Surveying

AUDIENCE:

- MOS 82D
- Skill Level 1/2

TRAINING OBJECTIVES:

- Soldiers completing this lesson should be able to:
  - Emplace nonstandard monuments
  - Emplace standard monuments
  - Mark survey monuments
  - Complete the administrative section of DA Form 1959
  - Complete the narrative description of DA Form 1959
  - Sketch the location of survey monuments

MATERIAL/EQUIPMENT/PERSONNEL REQUIRED:

- Printed text lesson
- Pencil or pen, paper, straight edge, copies of DA Form 1959, calculator (capable of performing square roots).

TIME REQUIRED:

- Individual: 60 min
- Group: 75 min

REFERENCE:

- STP 5-82D 1/2/3/4 Topographic Surveyor
- TM 5-232 Elements of Surveying
- TM 5-441 Topographic and Geodetic Surveying

READEX FICHE

STUDENT/SUPERVISOR INSTRUCTIONS

STUDENT INSTRUCTIONS:

- Prerequisites: None
  - Take the Pretest. If you pass, you do not have to take this lesson.
  - Make sure you have the material and equipment to take the lesson.
  - Request assistance if you have not taken a printed text TEC lesson before.
  - Work through the lesson as often as necessary to master the skills and knowledge covered by this lesson.
- When you complete the lesson, take the Posttest. If you do not pass, take the lesson again.

SUPERVISOR INSTRUCTIONS:

- Administer the Pretest to determine need for the lesson. If only one soldier is being tested, the test may be taken directly from the book, with responses on a separate sheet of paper. If more than one soldier is being tested, reproduce the test for direct use. To pass the test, a soldier must answer 20 of the 25 test items correctly (80%).
- Make sure soldiers have the material and equipment required to complete the lesson, including several copies of DA Form 1959.
- Administer the lesson to soldiers who do not pass the Pretest.
- If possible, administer a performance test to the soldiers upon completion of the lesson.
- Administer the Posttest to soldiers who complete the lesson.
- Those who do not pass should take the lesson again.

PRETEST/POSTTEST

TEC LESSON 412-051-6781-A

EMPLACE, SKETCH AND DESCRIBE A
PERMANENT SURVEY CONTROL POINT

This test consists of 25 questions that cover every training objective of the lesson. These questions have a total value of 100 points. When you have completed the test, check your answers against the Pretest/Posttest Answer Key on page 59. If you do not score at least 80 points, you must take the lesson - or take it again if you have already taken it. Write your responses on a separate sheet of paper. Do not write in this book.

1. What are the two most important considerations for selecting the location of a permanent survey control point?
   a. Accessibility and intervisibility
   b. Accessibility and reliability
   c. Permanency and intervisibility
   d. Reliability and intervisibility

2. How can the permanency of rods or rebar stations be enhanced?
   a. Install guard posts
   b. Install witness posts
   c. Conceal the station
   d. Add poured concrete collar

3. What information is not stamped on a station mark?
   a. Station designation
   b. Position data
   c. Establishing organization
   d. Year emplaced

4. What would it not be advisable to drill a hole to emplace a survey disk?
   a. A large shale outcrop
   b. Bridge wing wall
   c. Granite mountain top
   d. Concrete parking lot

5. What is the primary purpose of a plumbing bench?
   a. Serve as a work platform
   b. Ensure station mark and reference marks are aligned
   c. Act as a tape support during emplacement
   d. Ensure surface subsurface n arks are aligned

6. How many reference marks should be emplaced for second order and higher stations?
   a. 1 required, 2 preferred
   b. 2 required, 2 preferred
   c. 2 required, 3 preferred
   d. 3 required, 4 preferred

7. How many cubic feet of dry concrete material will be needed to fill a hole 2'6" deep and 10" in diameter?
   a. 1.0
   b. 1.4
   c. 2.1
   d. 2.5

8. How many cubic feet of aggregate would be required to produce 4.3 cubic feet of concrete mix?
   a. 0.7
   b. 1.4
   c. 2.2
   d. 3.0

9. How many 50 lb bags of premix "Sacrete" would be required to produce 6.8 cubic feet of concrete mix?
   a. 17
   b. 14
   c. 7
   d. 4

10. In which direction should the arrow of a reference mark point?
   a. To magnetic north
   b. To other reference marks
   c. Along the line of traverse
   d. To the station mark

PRETEST/POSTTEST

11 - 19 Given the following information, fill out the administrative section of DA form 1959.

Station Campbell is a standard US Army Corps of Engineer disk stamped "Campbell 1946." It is located at Ft. Campbell, KY. The UTM grid coordinates are Northing 4,082,526.37, and Easting 325,668.23. Grid zone is 165 NAD 1927.

COUNTRY	TYPE OF MARK	STATION	
LOCALITY	STAMPING ON MARK	AGENCY (CAST IN MARKS)	ELEVATION (FT) (M)
LATITUDE	LONGITUDE	DATUM	DATUM
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	ESTABLISHED BY (AGENCY)
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	DATE / ORDER

TO OBTAIN GRID AZIMUTH, ADD ° ' " TO THE GEODETIC AZIMUTH

TO OBTAIN GRID AZ (ADD)(SUB) ° ' " TO THE GEODETIC AZIMUTH

OBJECT	AZIMUTH OR DIRECTION (GEODETIC)(GRID) (MAGNETIC) ° ' "	BACK AZIMUTH ° ' "	GEOD DISTANCE (METERS) (FEET)	GRID DISTANCE (METERS) (FEET)

20. How many paragraphs are required in the description of a station with reference marks?

a. 7
b. 6
c. 5
d. 4

21. An old description calls for a station to be located along a two lane road. A new four lane road was built in the exact location and the station was not found. Which recovery code would you list on DA Form 1959?

a. Destroyed
b. Disturbed
c. Reset
d. Not recovered

22. What is the minimum number of reference points that should be described in the "Station Site Description"?

a. 3
b. 2
c. 1
d. 0

23. Azimuths in the "Station Site Description" should be listed from the station to the reference points.
    a. True
    b. False

24. Sketches drawn on DA 1959 need not be drawn to scale.
    a. True
    b. False

25. Which of the following does not have to be included on the sketch?
    a. The survey line
    b. Other survey stations
    c. "To Reach" termination point
    d. All RPs listed in the narrative

INTRODUCTION

OVERVIEW

One of the important tasks of the Topographic Surveyor is to establish permanent survey control stations and make a permanent written record of the exact location of the station on DA Form 1959 (Fig. 1-1). Once a station has been established, making it permanent and recoverable allows for quick access and repeated use. These are essential features when time is critical.

In this lesson the terms "station," "survey control point" (SCP) and "monument" are used interchangably.

OBJECTIVES:

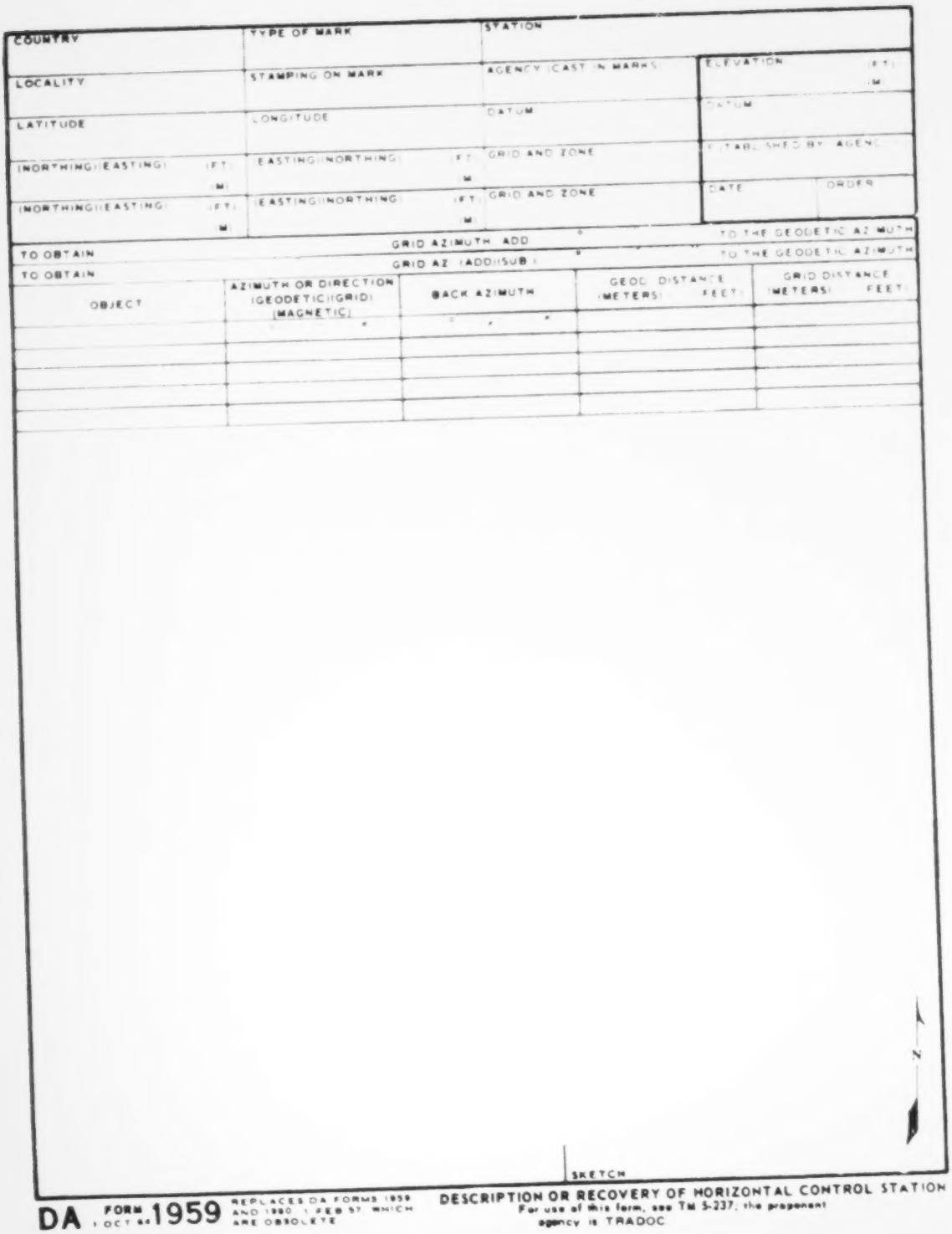
1. In this lesson you will learn to emplace and mark monuments. These monuments, or stations, are marked in a variety of ways depending on the situation and the availability of materials. Although the classic monument is a standard brass disk set into a poured concrete post, there are many variations of this standard also used.

2. You will also learn to sketch and describe the location of monuments since once the station is established, a DA Form 1959 "Description or Recovery of Horizontal Control Station" is used to describe the exact location of the monument to facilitate locating the station at some future time (Fig. 1-2).

OBJECTIVE 1. Emplace and Mark Monuments

The two most important considerations of any survey control point (SCP) are permanency and intervisibility. Normally, your squad leader or party chief will select the site of the SCP. Once this determination has been made, the station must be emplaced.

Depending on the availability of materials and the time requirement, you may have to emplace a nonstandard monument. A surveyor's imagination and experience are the only limiting factors involved in the selection of nonstandard monuments. Metal rods, rebars, pipes, shell casings or wooden hubs could be used. Some are more permanent than others and are therefore preferred.



COUNTRY	TYPE OF MARK	STATION	
LOCALITY	STAMPING ON MARK	AGENCY (CAST IN MARK)	ELEVATION (FT) (M)
LATITUDE	LONGITUDE	DATUM	DATUM
(NORTHING) (EASTING) (FT) (M)	EASTING (NORTHING) (FT) (M)	GRID AND ZONE	ESTABLISHED BY (AGENCY)
(NORTHING) (EASTING) (FT) (M)	EASTING (NORTHING) (FT) (M)	GRID AND ZONE	DATE ORDER

TO OBTAIN GRID AZIMUTH ADD ° ' " TO THE GEODETIC AZIMUTH

TO OBTAIN GRID AZ (ADD) (SUB) ° ' " TO THE GEODETIC AZIMUTH

OBJECT	AZIMUTH OR DIRECTION (GEODETIC) (GRID) (MAGNETIC) ° ' "	BACK AZIMUTH ° ' "	GEOD DISTANCE (METERS) (FEET)	GRID DISTANCE (METERS) (FEET)

N

SKETCH

DA FORM 1 OCT 64 1959 REPLACES DA FORMS 1959 AND 1960, 1 FEB 57, WHICH ARE OBSOLETE

DESCRIPTION OR RECOVERY OF HORIZONTAL CONTROL STATION

For use of this form, see TM 5-237; the proponent agency is TRADOC

FIGURE 1-1

COUNTRY	TYPE OF MARK	STATION	
United States	BRASS DISK	FB-10/GT-18 (ERDL, 55) (SO II)	
LOCALITY	STAMPING ON MARK	AGENCY (CAST IN MARK)	ELEVATION (FT) (M)
FORT BELVOIR, VA	FB-10, GT-21, ERDL 55	US ARMY C of E	36.973
LATITUDE	LONGITUDE	DATUM	DATUM
38° 41' 53."841	–77° 08' 47."656	NAD 1927	SEA LEVEL 1929
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	ESTABLISHED BY AGENCY
4 285 278. 036	313 323. 460	UTM 18S	Defense Mapping Agency
[redacted](EASTING) [redacted] (M)	[redacted](NORTHING) [redacted] (M)	GRID AND ZONE	DATE 1979 ORDER Third

TO OBTAIN GRID AZIMUTH ADD ° TO THE GEODETIC AZIMUTH				
TO OBTAIN GRID AZ (ADD)(SUB) ° TO THE GEODETIC AZIMUTH				
OBJECT	AZIMUTH OR DIRECTION (GEODETIC)(GRID) (MAGNETIC)	BACK AZIMUTH	GEOD DISTANCE (METERS) (FEET)	GRID DISTANCE (METERS) (FEET)
	° ' "	° ' "		

RECOVERED: The station is located on the South Post of Ft. Belvoir VA in the vicinity of Bldg. T-1083.

The station is located at a mag. az. of 70° at a distance of 2.4m from the east rail of the railroad tracks, at a mag. az. of 270° at a distance of 3.7m from a power pole, at a mag. az. of 165° at a distance of 38.1 m from the southwest corner of Bldg. T-1083.

To reach the station from the Main Gate of the South Post of Ft. Belvoir travel south on Belvoir Road 0.6 mi (1.05 km) to the intersection of Belvoir Road and 9th St. Turn right (west) 0.48 mi (.73 km) to the interesction of Gunston Road. Turn left (south), proceed 0.1 mi (0.14 km) on Gunston to the south of Bldg. T-1083 and the station site.

The station is a standard US Army Corps of Engineers brass disk stamped "FB-10 GT-18, ERDL 55" set in a 20-cm diameter post projecting 5 cm above ground level.

Visibility from tripod height is restricted to less than 200 m in all directions except on the line parallel with the railroad tracks. Northward restricted to 380 m, southward 1000 m.

SKETCH

DA FORM 1 OCT 84 1959 REPLACES DA FORMS 1959 AND 1960, 1 FEB 57, WHICH ARE OBSOLETE

DESCRIPTION OR RECOVERY OF HORIZONTAL CONTROL STATION

For use of this form, see TM 5-237; the proponent agency is TRADOC

FIGURE 1-2

A. Emplacing Nonstandard Monuments

1. Metal Rods

A variety of metallic rods are commercially available for use as survey monuments (Fig. 1-3).

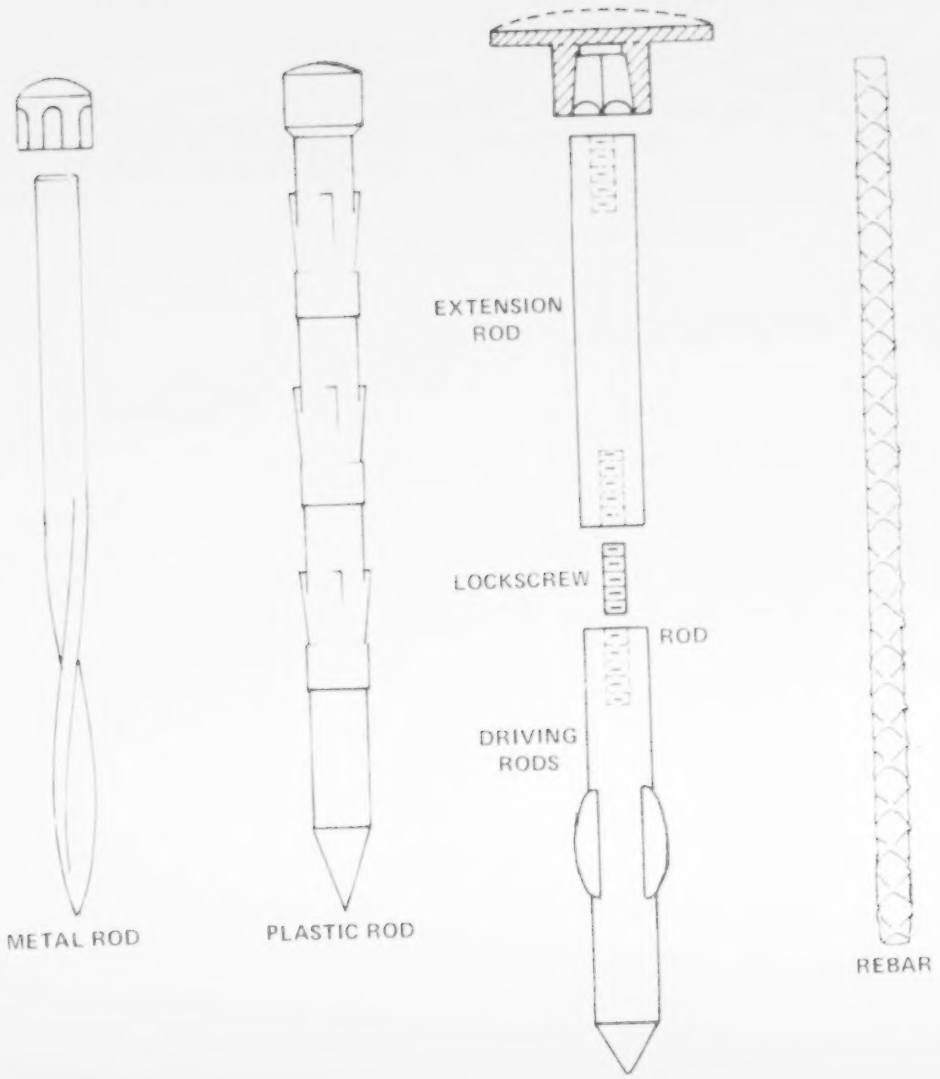


FIGURE 1-3. SECTIONAL METAL RODS

Many of these come in threaded sections with a driving cap. Once the location of the station has been determined, the rod is assembled with the driving cap in

place on top of the rod. The rod is then driven into the ground with either a sledge hammer or slide hammer (Fig. 1-4). It should be driven to a point of resistance; that is,

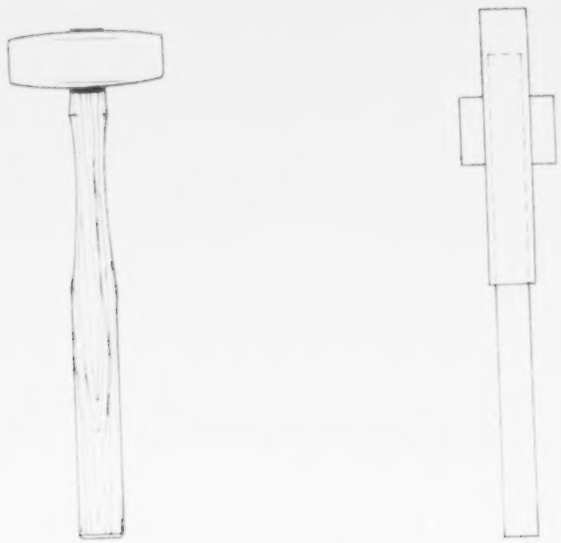


FIGURE 1-4.

driven until it will go no farther into the ground. If needed, additional sections should be added to the rod to ensure the point of resistance is met. The driving cap is then removed and the station cap is emplaced on the rod. Some rods do not have a survey cap. It then becomes necessary to center punch the driving cap. This center punched mark becomes the exact location of the point. Additional marking of the station will be discussed in Section B.

2. Re-bar (Reinforcement Steel Bar)

Re-bar can be used to mark a permanent survey control station. It is emplaced in a similar fashion to the metal rods except that the required length must be determined before it is driven into the ground. Although no minimum length or diameter exists, a good "rule of thumb" dictates that the steel should be approximately 1 m (39.3 in) in length and approximately 1 cm (1/2 in) in diameter. Once driven, the end of the bar must be center punched to mark the exact location of the station.

When time permits, the permanency of both metal rods and rebar monuments can be increased by pouring a concrete cap or collar around the monument. To do this, the top of the previously set monument is excavated to a depth of approximately 30 cm by 30 cm (1 ft by 1 ft) in diameter. Care must be exercised, particularly if the station has already been surveyed, to ensure the station is not disturbed. A mixture of 1

part cement, 2 parts sand and 3 parts aggregate should be poured into the hole. The top surface should be leveled and smoothed (Fig. 1-5).

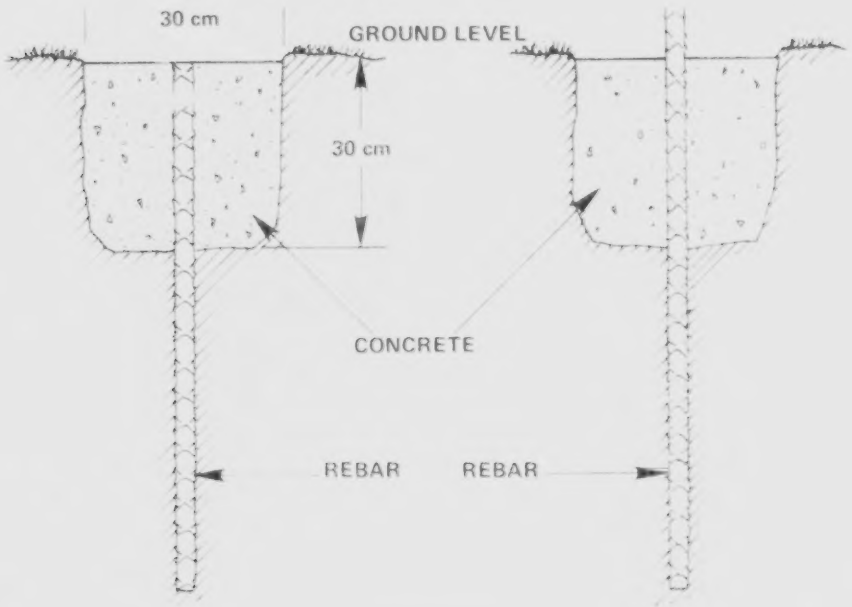


FIGURE 1-5

Care should be taken to ensure the mark itself is not obscured by the concrete mix.

Some local SOPs call for the rebar or survey cap to project above ground level, and therefore above the top surface of the concrete. This is an acceptable procedure, but not recommended. The projecting mark is somewhat easier to find but it is also more susceptible to damage.

3. Pipe

Another nonstandard monument that can be used is lengths of pipe. Obviously soft pipe would not be advisable as it would bend or otherwise be damaged driving it into the ground. Pipe of less than 2 cm (3/4 in) should also be avoided. Once in the ground, the pipe must be capped in order to allow a center mark denoting the exact location of the point. The cap will either be a standard disk brazed onto the pipe, a threaded standard pipe cap or a piece of metal brazed on the pipe.

In permafrost areas, a wrought iron water pipe 0.05 to 0.10 m (2 to 4 in) in diameter and 1.22 m (4 ft) or more in length, is desirable. The pipe should extend through the active (freeze and thaw) layer into a good bond with the permafrost layer. Holes should be drilled in the lower end of the pipe and the lower part filled with water for an ice bond with the permafrost. The standard disk is brazed to the upper end of the pipe.

4. Shell Casings

On military reservations a wide variety of expended nonreusable shell casings may be available for use as nonstandard monuments.

NOTE

It is highly recommended that you check with range control before using large caliber shell casings as survey monuments.

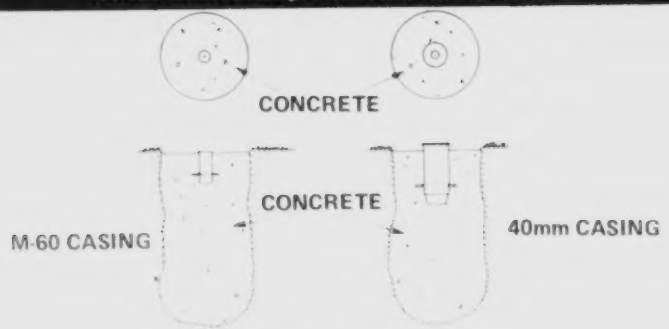


FIGURE 1-6.

To emplace a shell casing, excavate a hole approximately 0.6 m (2 ft) deep and 35 cm (13-14 in) in diameter.

NOTE

See Objective 2 if a subsurface mark is also required.

Concrete is mixed at a 1:2:3 ratio as described on page 12. The hole is filled with concrete to ground level. A metal pin should be driven through the bottom of the shell casing to ensure it cannot be removed from the finished concrete post (Figure 1-6). If a large casing is used (105 mm), it is advisable to fill the casing with cement before placing it in the poured concrete. Press the casing into the concrete until it is almost flush with the top of the cement level, finish the concrete and allow the monument to set overnight before doing any backfilling (Figure 1-7).

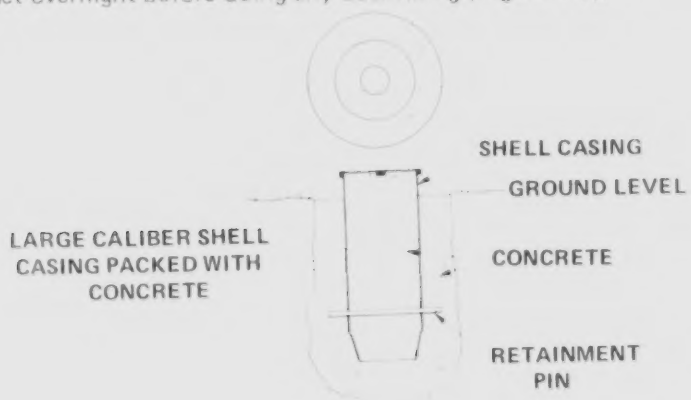


FIGURE 1-7.

5. Wooden Hubs, etc.

Wooden hubs, flats, nails, bolts, etc. may from time to time be used as survey control points. However, because wood rots or splinters and the other examples may be extracted, they are seldom used as permanent markers.

B. Marking Nonstandard Monuments

All monuments must be marked so that no confusion can possibly exist as to the identity of the monument. The stamping on standard monuments will be discussed later. Here we will only discuss the marking of nonstandard monuments.

The basic information that should be on all monuments is:

- Station designation (either name or number)
- Establishing organization (your unit)
- Date (usually the year)

1. Stations that have a poured concrete cap are the easiest to mark. After the cement has cured for a short time (perhaps an hour) a nail can be used to scribe the information directly in the cement. This should be done as neatly and legibly as possible (Figure 1-6).

2. Shell casing monuments can have this information stamped onto the casing itself.

3. The last alternative is a tag with the information written in indelible ink and wired to the monument.

NOTE

For witness posts and guard posts see the section under standard monuments, page 15.

C. Emplace Standard Monuments

Standard monuments are generally defined as any survey mark that has a precast brass or alloy disk. A number of agencies produce these disks. Some of the more common disks are those produced by the US Army Corps of Engineers (USCofE), US Coast and Geodetic Survey (USC&GS), National Geodetic Survey (NGS), United States Geologic Survey (USGS), the Defense Mapping Agency (DMA) and others (Figure 1-8).

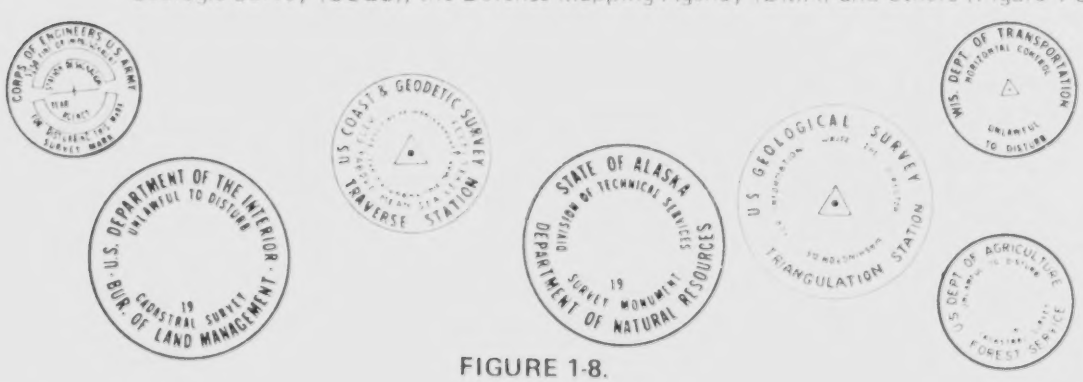


FIGURE 1-8.

Although somewhat different in appearance, all of these marks have these features (Figure 1-9):

- The name of agency that produced the disk cast into the disk itself.
- A center point already clearly marked.
- A space for the using agency to stamp its name, station designation and date on the disk.

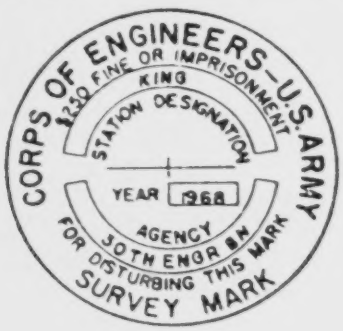


FIGURE 1-9.

1. Emplacing a Standard Monument in Rock Outcrop or Previously Poured Concrete.

In many areas, and under many circumstances, it may be advisable to emplace a standard disk in a natural rock outcrop or in a previously poured slab of concrete, such as a bridge abutment. Remember, one of the primary considerations of the location of a survey monument is permanency. Any rock outcrop used for the location of a survey monument must be a substantial rock of a solid nature. Obviously, a large slab of slate or shale would not be advisable as they erode and break easily.

In the mountains of the western United States, most survey monuments are emplaced in the natural rocks on top of the ridges.

Bridge abutments are routinely used as either bench marks or horizontal control points. Located on roadways or rail lines, they are already on some of the most preferred survey lines. The amount of concrete typically used in construction of abutments and wing walls makes their permanency unquestionable (Figure 1-10).

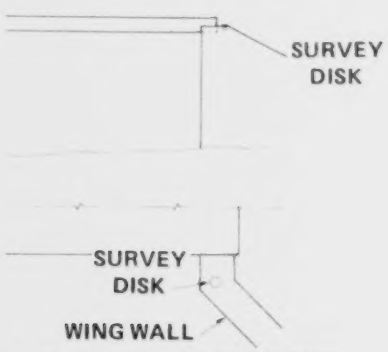


FIGURE 1-10. BRIDGE ABUTMENT

The procedures for placing a disk in either case are identical.

- Select an area that is reasonably flat and will accommodate a survey tripod.
- Using a star drill and hammer of at least 2 lbs., drill a hole in a solid section of rock at least 2.5 cm (1 in) deeper than the length of the shank of the disk (Figure 1-11a). Avoid the edges of the feature as it will crumble and the mark will be lost.

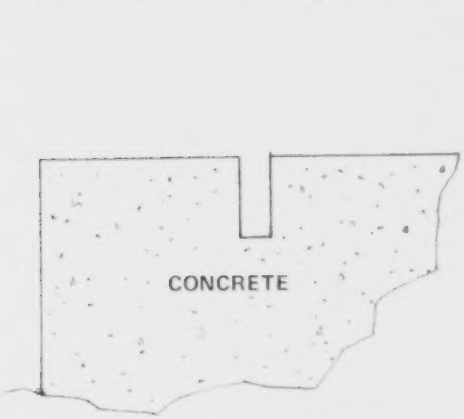


FIGURE 1-11a. STAR DRILL HOLE

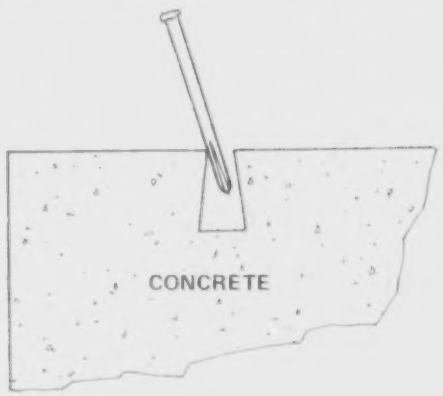


FIGURE 1-11b. BELLED STAR DRILL HOLE

- By placing the drill at an angle, slightly "bell" the bottom of the hole (Figure 1-1 (b). This will ensure that the disk cannot be pulled out of place.
- Clean the hole to remove all loose particles.
- Fill the hole with epoxy resin.
- If the shank of the disk is split (Figure 1-12a) spread the shank open (Figure 1-12b).

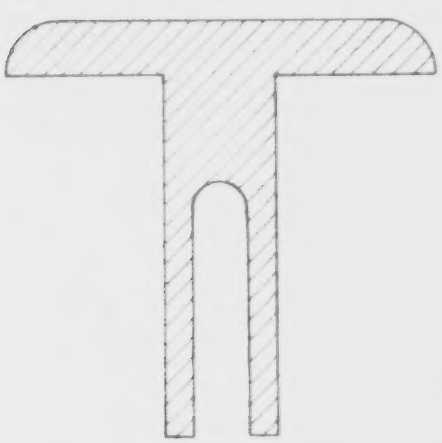


FIGURE 1-12a. DISK CROSS SECTION

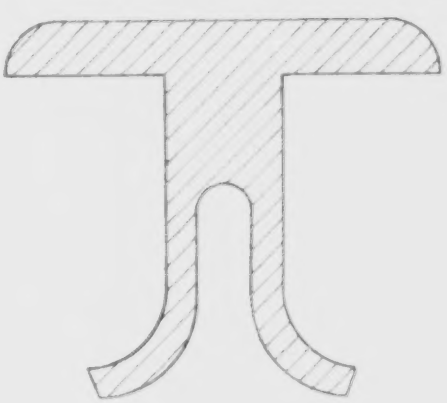


FIGURE 1-12b. DISK CROSS SECTION WITH SPREAD SHANK

- Press the disk into the hole until the disk itself is flush with the surface of the rock. Minor adjustments may be required to ensure that the disk is flat and usable as a bench mark or horizontal control point. It is advisable to let the disk "set" until the epoxy resin has hardened completely.
- Ensure that the resin is completely filling the space between the disk and feature.

NOTE

See page 14 for stamping disks.

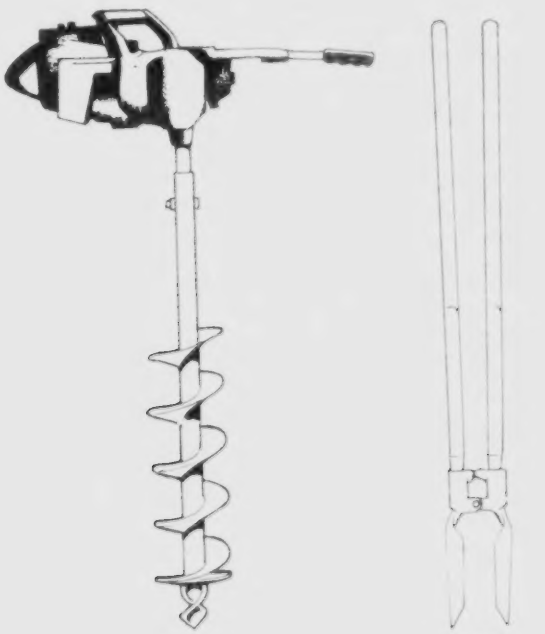
2. Emplace Standard Poured Monuments

The classic standard monument is one that must be completely poured concrete with the disk set in the top of the concrete.

NOTE

The procedure described here and the dimensions cited are for second order and higher monuments. For third order the size may be reduced.

a. There are a series of steps to this procedure. Excavate a hole approximately 1.0 to 1.5 m (3.3 to 5.0 ft) below ground level. In all cases it must be dug to a point well below the active frost zone. This hole will typically be dug with a power auger, a hand auger or shovels and post hole diggers (Figure 1-13). "Bell" the lower



POWER AUGER

POST HOLE DIGGER

FIGURE 1-13.

section of the hole to ensure permanency of the mark (Figure 14). This type of monument will normally require a subsurface monument.

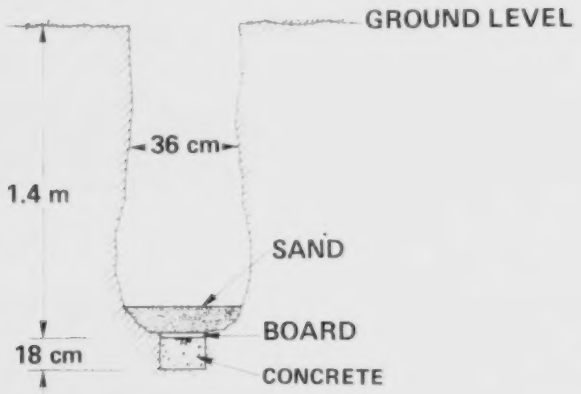


FIGURE 1-14.

b. Emplace the subsurface mark so that in the event the surface mark is destroyed, it can be reset in the correct location without the need of being resurveyed. The subsurface mark may be a standard disk. If so, it must be marked in the fashion described on page 15 or it may be a nail or bolt inserted into the concrete. Once the initial excavation is completed and all loose materials are removed:

- Post hole diggers are used to dig an additional 15 cm x 15 cm (6 in x 6 in) hole in the bottom of the original hole.
- The shank of the subsurface disk is spread and the disk is emplaced in the cement.
- Using a trowel, the cement should be tamped to ensure complete bonding of the cement to the disk (Figure 1-14).
- Allow 24 hours for the cement to cure before any further work is done on the monument.

c. The next step in emplacement is to build a plumbing bench, after the concrete has cured. The bench is normally constructed of well-cut lumber and must be sturdy enough to allow its partial removal.

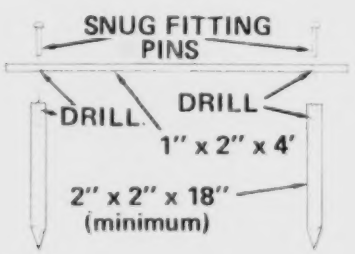


FIGURE 1-15.

- With assistance, lower a plumb bob to the exact center of the subsurface mark (Figure 1-16a).

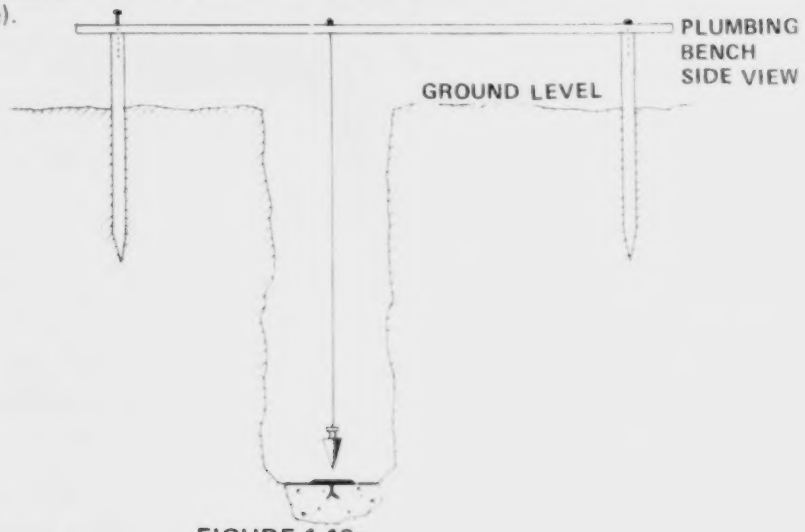


FIGURE 1-16a.

- Drive two stakes into the ground on opposite sides of the hole at least 0.5 m (2 ft) away from the hole.
- Drill the cross piece at the point it joins the stakes.
- Drive a nail through one hole of the cross piece and into one stake.
- Pass the drill bit through the other hole and drill into the ground stake.
- Place a nail or pin in these two holes and ensure it is tight but can easily be removed.
- Mark the cross piece at the exact location where the plumb line touches it (Figure 16b).

NOTE: Great care must be taken at this point to ensure the mark on the cross piece is in the exact position as that on the subsurface mark.

- Once this is assured, remove the plumb bob, pull the pin and carefully swing the cross piece out of the way (Figure 16b).

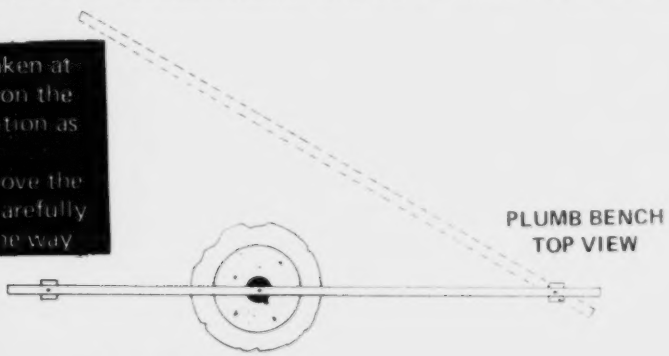


FIGURE 1-16b.

NOTE
It is very important not to disturb the stakes or cross piece at any time.

Normally a form will be built for the top of the monument, particularly if the local unit SOP calls for the monument to project above ground level. The form

will typically be 30 cm x 30 cm (12 in x 12 in x 12 in) and should be tapered toward the top (Figure 1-7).

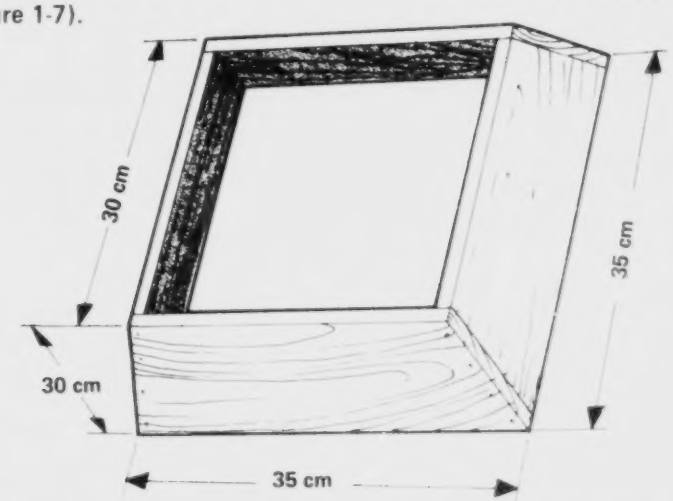


FIGURE 1-17. FORM FOR POURED CONCRETE MONUMENT.

If no other materials are available, a piece of 30 cm (12 in) diameter pipe, 30 cm (12 in) long could be substituted. Obviously, this form could never be removed. To install the form it may be necessary to dig a little more around the top of the hole. If so, be sure to backfill any excess and ensure that the form is well pinned down to preclude breaking. Concrete is very dense and can break an unstable or poorly made form.

d. Preparing and Pouring Concrete. Remember, this may be a remote location and all the materials may have to be packed into the site, so it is necessary to estimate the amount of concrete required.

(1) Calculations

- To do this, the cubic volume of the excavated hole must be determined. If the hole is basically cylindrical, the volume can be estimated by the formula:

$$\text{Vol} = \pi r^2 h$$

where $\pi = 3.14$

r = the radius or 1/2 the diameter

h = the depth of the monument.

As this is a rough estimate it is advisable to add 50 percent. It is better to have a small amount of cement left over than not to have enough. When cement is mixed the resultant volume is less than the

sum of the additive parts. Adding 50 percent allows for this change in volume.

- Once the cubic volume is known, the proportion of each material must be determined. You should use the standard 1:2:3 mix of cement, dry sand and aggregate. For ease of computation, fractions may be used as follows:

Cement – 1 part 1/6 x vol = cement
Dry sand – 2 parts 2/6 x vol = dry sand
Aggregate – 3 parts 3/6 x vol = vol aggregate.

Now, let's look at an example. Given a hole of 14 in diameter and 4.5 ft depth, how much concrete would be required?

Using the formula:

Cubic volume = $\pi r^2 h$,

First convert the diameter to the radius in decimals:

Parts of a ft 14"/2 = 7"/12 = 0.58ft

Cubic volume = 3.14 (0.58) x 4.5 = 4.8 cubic ft.

Allowing for excess, multiply x 1.5

4.8 x 1.5 = 7.2 cubic Ft.

To compute the volumes of each substance:

Cement = 1.6 x 7.2 = 1.2 cubic ft
Sand = 2/6 x 7.2 = 2.4 cubic ft
Aggregate = 3/6 x 7.2 = 3.6 cubic ft.

As a general rule:

60 lbs of concrete = 0.5 cubic ft
50 lbs of sand = 0.5 cubic ft
50 lbs of aggregate = 0.5 cubic ft.

If materials must be procured by weight, a simple ratio will give required weight:

$$\text{Cement} = \frac{0.5 \text{ ft}}{60 \text{ lbs}} = \frac{1.2 \text{ ft}}{x}$$

$$0.5 \text{ ft} \quad x = 1.2 \text{ ft} \times 60 \text{ lb}$$

$$x = \frac{1.2 \text{ ft} \times 60 \text{ lb}}{0.5 \text{ ft}}$$

$$x = 144 \text{ lbs}$$

$$\text{Sand} = \frac{0.5 \text{ ft}}{50 \text{ lbs}} = \frac{2.4 \text{ ft}}{x}$$

$$x = 240 \text{ lbs}$$

$$\text{Aggregate} = \frac{0.5 \text{ ft}}{50 \text{ lbs}} = \frac{3.6 \text{ ft}}{x}$$

$$x = 360 \text{ lbs}$$

Another simpler method, based on availability, is to use premixed concrete (commercially known as Sacrete or Quickrete). This is a premixed compound except for water. This mixture usually comes in 50 lb bags which equals approximately 0.5 cubic foot. Therefore, for our example:

$$\frac{0.5 \text{ ft}}{1 \text{ bag}} = \frac{7.2 \text{ ft}}{x}$$

$$x = 14.4 \text{ bags} = 15 \text{ bags.}$$

Normally, six or seven gallons of water will be sufficient for either mix. The water should be clean and free of chemicals. Some hard waters, as well as muddy water, will lessen the overall strength of the mix.

NOTE
Reinforcement bars should not be used in monument construction. Even though the bars add strength, they also make the monument less stable.

For practice, compute the needed amounts of both loose materials and premixed materials in the following example.

Given a monument hole with a diameter of 18 in and depth of 5.0 ft, what materials would be needed?

Answer: You should have determined the overall volume of 8.8 cubic ft using the 50 percent-additional-materials rule for allowance of compaction and excess, which yields 13.2 cubic ft.

Required Materials:

	Volume	Weight
Cement	2.2 cubic ft	264 lbs
Sand	4.4 cubic ft	440 lbs
Aggregate	6.6 cubic ft	660 lbs

Pre-mix = 26.4 bags.

Remember, these dimensions are for first or second order stations. The dimensions may be reduced for third or lower order stations.

If you have any difficulties, review the section on concrete computation again before proceeding.

(2) Mixing and Pouring.

Now that all the materials have been gathered and the top of the monument has been formed, you're ready to mix the concrete.

- Add sufficient water to allow for a smooth, consistent mix.
- Make sure all the materials are thoroughly mixed.
- Cover the subsurface mark with a thin board and 2 to 3 inches of sand.
- Carefully pour the mix into the form. Do not disturb the plumbing bench stakes at any time.
- While pouring the cement, tamp it with a blunt stick. This will ensure there are no air bubbles in the mix and that the entire cavity is filled.
- Fill to the top of the form and screed and smooth the top of the cement.
- At this point, swing the cross piece of the plumbing bench back into position and reinsert the pin.
- Lower the plumb bob from the mark on the plumbing bench and lightly mark the wet concrete.
- Carefully remove and clean the plumb bob.
- Spread the shank of the disk open and press it into the cement so that the center of the disk is directly on the point marked in the cement.
- Replace the plumb bob and move this until it is exactly under the mark on the plumbing bench.
- Make sure there is no space under the disk.
- Check to make sure the disk is still centered and finish the concrete to a smooth finish.

- Allow at least 24 hours for the concrete to cure before any other activities are done at the station site.
- Remove the form and backfill any portion of the hole that may be still exposed (Fig 1-18).

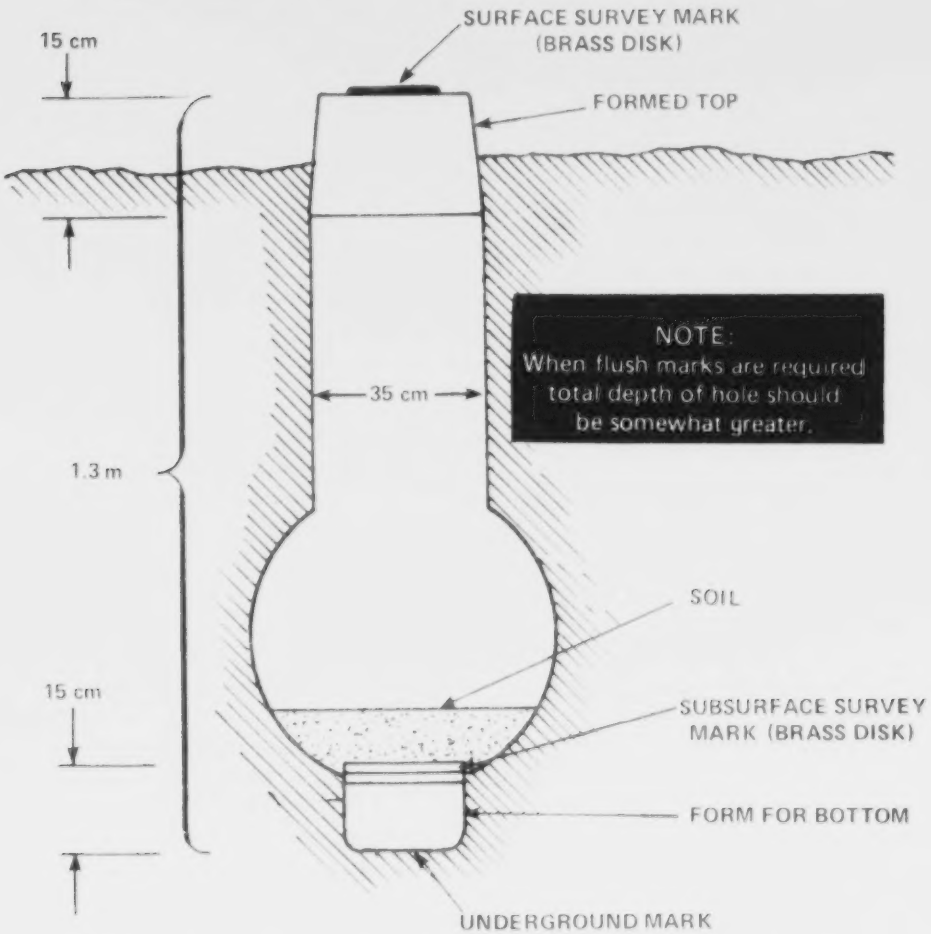


FIGURE 1-18. SAMPLE CONCRETE MONUMENT INSTALLATION.

(3) Emplace Standard Precast Monuments

In many circumstances, it may be more convenient and expedient to build precast monuments. These monuments or "stones" are made of the same mix of concrete as poured monuments but precast monuments are poured into a completely built form. The disk is emplaced with the intention of stamping the disk at a later time. Often it is advisable to get assistance from a local engineer office when actually making the stones. The most important consideration is the size and shape of the precast stone. It must be more or less triangular and small enough to be

transported by two individuals (See Figure 1-19 for shape and approximate size).

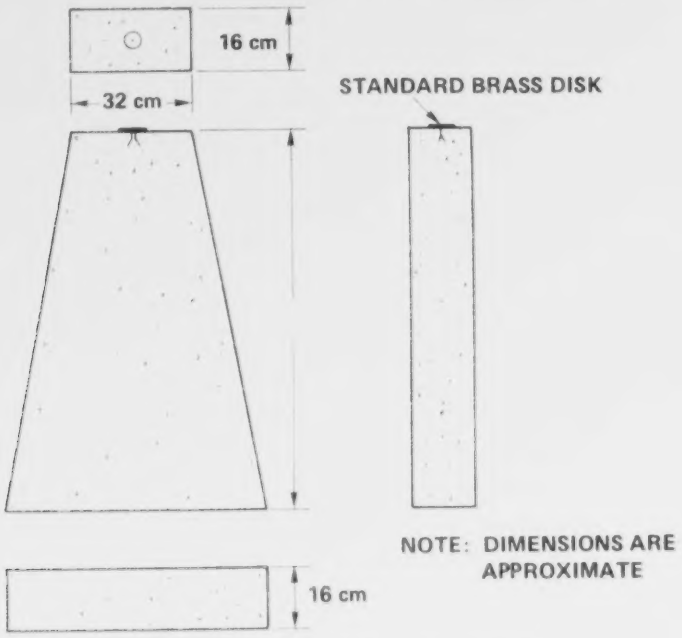


FIGURE 1-19. PRE-CAST CONCRETE MONUMENT

To emplace this type monument, the primary excavation is the same as for the poured monument, allowing for the subsurface mark if one is required.

- Again using the plumbing bench, the stone is carefully lowered into the hole, centered, and backfilled.
- While backfilling, add small amounts of soil and tightly tamp the materials.
- Assure that the center of the disk is always kept directly under the plumb bob.
- Small amounts of water can be added while tamping to ensure the materials are packed tighly around the monument, and the stone cannot be moved.

D. Emplace Reference Marks and Azimuth Marks

All first and second order monuments require reference marks. A minimum of 2 reference marks are required with 3 being preferred. Although not required on third order marks, when time and materials allow, such marks should be made.

Reference marks serve two purposes. First, they simplify finding the station mark and second, if the station mark is destroyed, it can be replaced based on the reference marks, or the subsurface mark.

The reference marks are emplaced in a manner similar to the station mark, except the dimensions of the monument can be reduced. The arrow on the reference mark disk must point directly at the station (Figure 1-20).

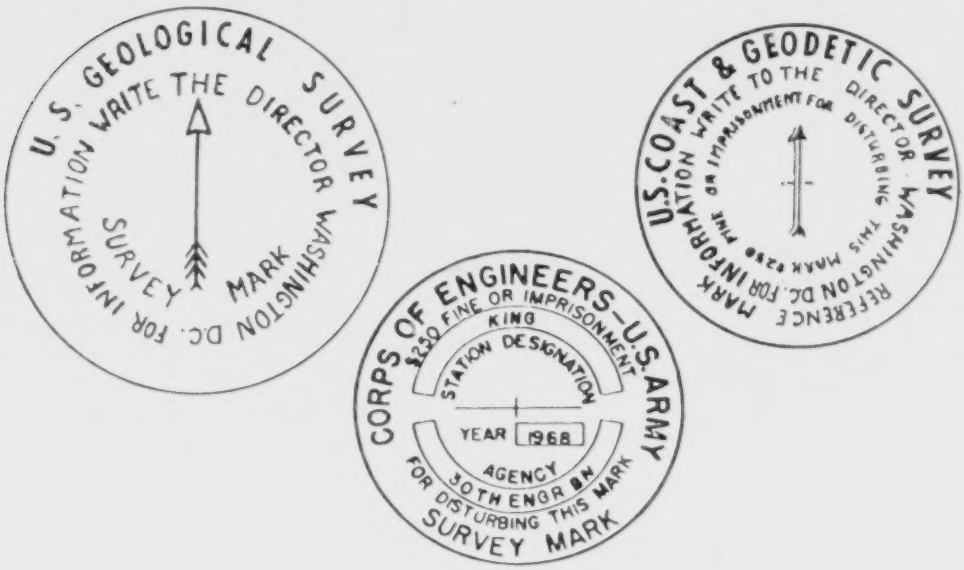


FIGURE 1-20.

The reference marks should be set at right angles to each other at distances of less than 30 meters. Additionally, if possible they should be set at the same elevation as the station mark. Once emplaced (Figure 1-21), the distances from the center of the reference marks to the center of the station mark must be carefully measured and recorded.

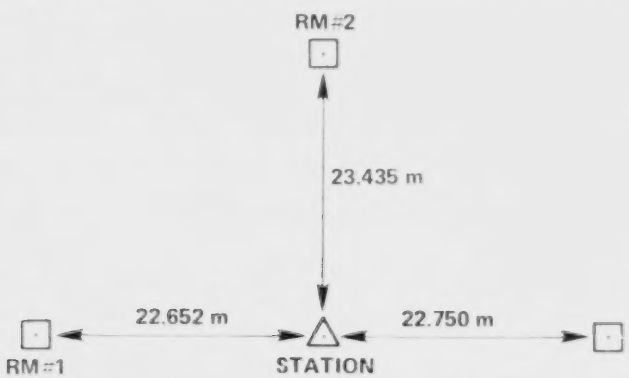


FIGURE 1-21. RMs AT STATION SITE
AZIMUTHS DETERMINED BY SURVEY

When the survey is conducted, the azimuths to the marks are also determined and recorded. With this information, the station could be "reset" if needed.

Azimuth marks (Figure 1-22) are emplaced the same as reference marks except the distance is typically greater.

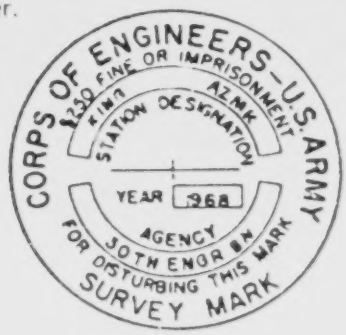


FIGURE 1-22

Azimuth marks should be no less than 200 m and up to 400 m in distance from the station. The arrow on the azimuth mark will point directly at the station. The exact azimuth will be determined when the survey is conducted.

E. Marking Standard Stations

The actual stamping of information on the disk should ideally be done prior to the disk being set in concrete. However, often it must be done after the disk has been set. The procedure described here is for stamping prior to emplacement except as noted.

Using Die Set, Metal Stamping 3/16" (NSN 5110-00-293-1905) all letters and numbers are clearly stamped into the disk. If you have never used tap dies, it is important that you practice stamping names and numbers prior to using a disk. Practice on a piece of soft metal such as brass or aluminum, or a block of wood. Never use a stamping set on hard steel as the dies can be damaged. To make the finished designations as neat and legible as possible, lay out exactly what you intend to imprint in box fashion (Figure 1-23a). Remember the standard die contains 3/16" figures. Use a pencil to

FIGURE 1-23a.

draw directly on the material. This will let you determine correct spacing for each character. The laid out boxes should be 1/4 in square. Carefully stamp each letter or

number in the center of each box. With practice this will become increasingly easy.

When you can perform this on a straight line, take a standard survey disk and trace the station designation block (Figure 1-23b). Now you are working on a curved

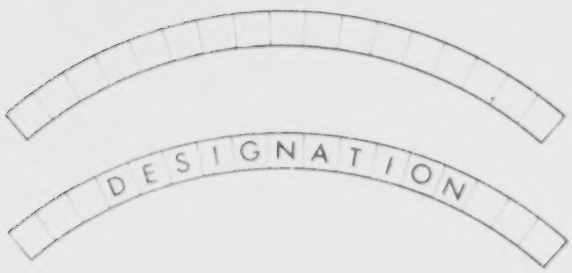


FIGURE 1-23b.

surface. You may have to change the spacing of the characters to ensure that they will fit the allotted space and look balanced.

Transfer this curved space to your practice stock and practice stamping on the soft material.

Once you have mastered the technique, you will be ready to stamp a disk. Be careful and be sure you are truly ready. Disks are expensive and they are permanent. Future generations of surveyors will refer to your work so you want it to be an accurate reflection of your care and precision.

The minimum information you will stamp on a station disk is the station designation (either a name or series of numbers), the unit establishing the station, and the current year. For reference marks, prior to emplacement the RM number and the station name to which it is a reference mark would be stamped. Normally after the reference mark is emplaced and the distance has been measured to the station, you will stamp that distance on the reference mark.

Azimuth marks may be stamped prior to emplacement and will be stamped with the station name and year. If standard azimuth mark disks are not available, the

standard disk would be stamped with the station name and AZ MK and year. As an example, "Belvoir AZ MK 1957."

F. Witness Posts and Guard Posts

Once all disks have been stamped, all that is left to do is to mark the station site for future reference. Depending on unit SOP and available materials, a witness post should be erected. This applies to all permanent stations, standard and nonstandard. In certain areas it may be advisable to mark the station temporarily. This can be accomplished by driving a 2 in x 2 in x 4 ft or 2 in x 1 in 4 ft stake near the station. Normally, the station name will be written either on the stake or on a tag attached to the stake (Figure 1-24a). Often a more permanent witness post will be required, as for

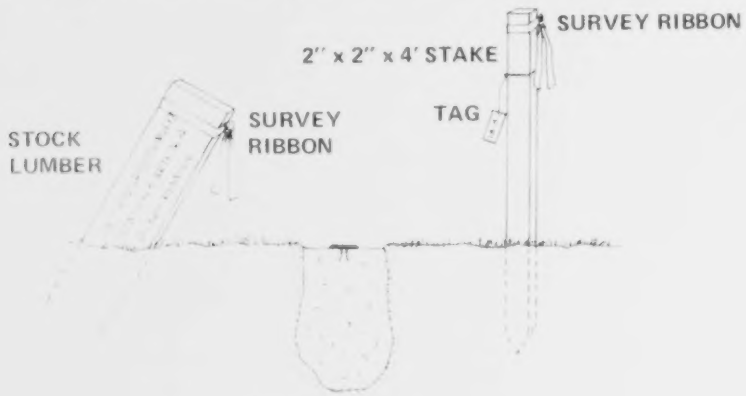


FIGURE 1-24a.

a frequently used station. In this case, a standard sign post is driven in the ground or, if time allows, a hole excavated and the base of the post cemented into the ground. A sign is then attached to the post (Figure 1-24b). In areas where the station could be

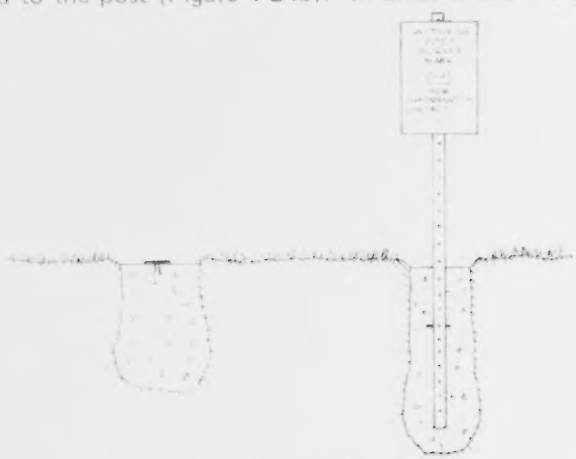


FIGURE 1-24b.

damaged (ex., located by a tank trail) it is recommended that guard posts be emplaced. The guard posts must be made of some type of substantial material. That material will depend on what is available. Some examples of these materials would be:

- Sections of railroad rails
- 10 in x 12 in or equivalent heavy stock lumber such as cross ties
- Heavy pipes

The posts should be at least 7 ft in length. The holes should be excavated to a depth of 1 m (3 ft) and filled with at least 2 ft of concrete (Figure 1-25), with the post projecting 4 ft above ground. The posts should be placed no closer than 1 m (3 ft) from the

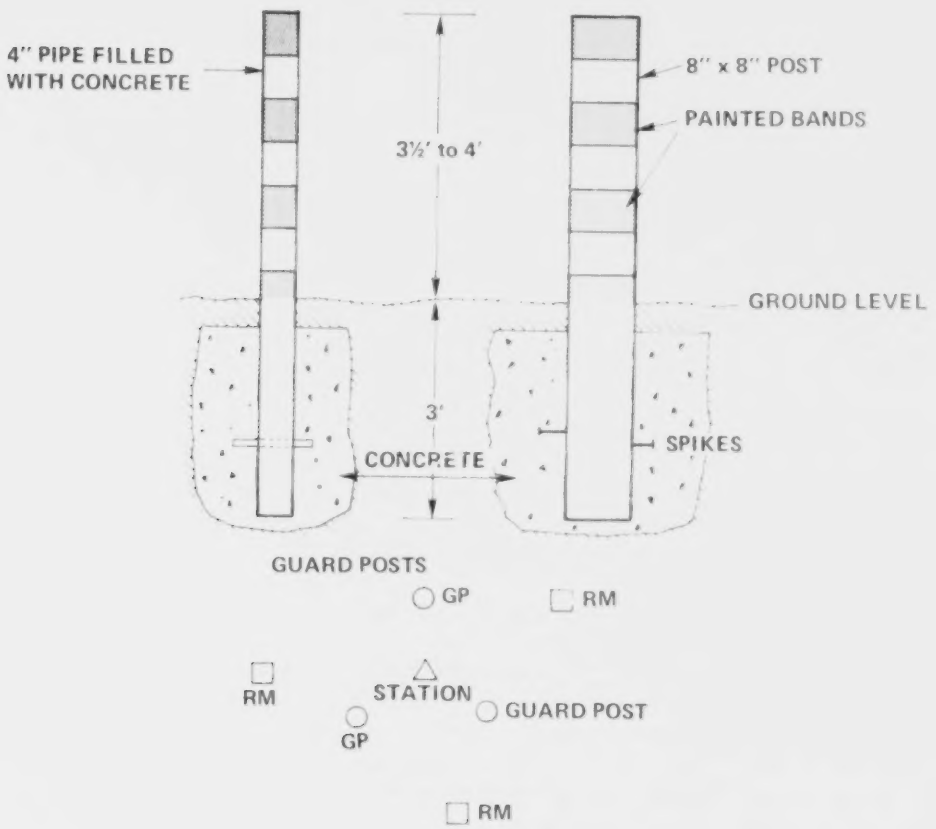


FIGURE 1-25

station. This will protect the station and should not interfere with normal operations at the station site. Additionally, depending on the situation, the guard post should be painted in a candy stripe fashion to allow people to see and avoid them.

PRACTICE EXERCISE I

1. How many bags of premixed concrete are required for a monument 16 in in diameter and 54 in deep?

   a. 12

   b. 13

   c. 18

   d. 19

2. When emplacing a disk in a rock outcrop, what type of rock should be used?

   a. Slate

   b. Shale

   c. Granite

   d. Sandstone

3. Which item is the least desirable to be used for a survey monument?

   a. Wooden hub

   b. Iron pipe

   c. Brass rod

   d. Bridge abutment

4. What is the primary consideration when placing a survey monument?

   a. Accessibility

   b. Available materials

   c. Ease of construction

   d. Permanency

ANSWERS FOR PRACTICE EXERCISE 1

1. d. Using the formula radius x depth = volume, the monument has a volume of 6.3 cubic feet. With a 50 percent excess required, the volume of concrete is 9.4 cubic feet. Since each bag contains 0.5 cubic foot, 19 bags are required.

2. c. You would always choose the most solid rock, which in these choices, would be granite.

3. a. Since wood can splinter or rot, a wooden hub is the least desirable type of survey monument.

4. d. Permanency is the primary consideration when placing a survey monument.

OBJECTIVE 2. Sketch and Describe the Location of Survey Monuments

The requirements for emplacing a permanent survey station are numerous. A station may be established to satisfy a one-time position requirement, to support a construction project, navigational aid, or weapon system, or it may have been established to extend control into a previously unsurveyed area.

Regardless of the reason, once established and adjusted, any station could potentially be used over and over again. Before this can happen, however, the station must be located. Witness posts and guard posts can be destroyed and the stations themselves can be hidden by undergrowth or buried by fill. Therefore, an accurate description and sektch will be essential in recovering a station.

DA Form 1959 "Description or Recovery of Horizontal Control Station" is the report that can be used to facilitate this recovery. Any time a new station is established or a previously surveyed station is recovered, a new DA 1959 should be completed.

DA 1959 can be broken down into three sections:

The administrative section
The narrative description
The sketch

We will cover all three sections in this lesson.

A. ADMINISTRATIVE SECTION

This section is used to identify the station and to list certain known data about the station. The back of DA 1959 is part of the administrative data and is used to identify the individual who actually wrote the description. Much of the information is self-explanatory but from time to time some questions do arise, so let's look at DA 1959. Take a blank DA 1959 and we'll let you work through a sample.

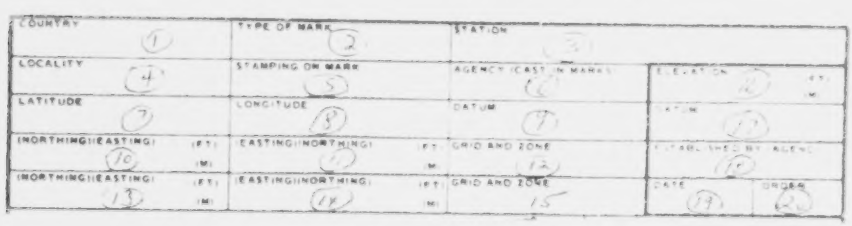


FIGURE 2-1

1. COUNTRY – List the country in which the station is located.

For your practice use the United States.

2. TYPE OF MARK – Note the type of mark. In the United States some examples would be "brass disk," or "105mm casing," "pipe station" etc.; that is, the physical description of the mark. In overseas areas, such as Germany, the marks are assigned

type numbers. These numbers will generally be listed in the Germany trig list (this list would be available to you in Germany) and that number will be written here.

For your sample use a brass disk.

3. STATION – The actual designation of the station is listed here. It may be a name or a number. Also the order and class of survey is listed, such as

First order class I becomes (FO I)
Second order class II becomes (SO II)
Third order class I becomes (TO I)

For your sample use Belvoir (First order class II).

4. LOCALITY – In most instances the name of the 1:50,000 scale map sheet on which the station is located is listed here. Generally, the name of the state will also appear. In some cases, such as military installations and government reservations, the name of these installations will be entered here with the appropriate state. Ex.: Ft. Belvoir, VA

For your example use Ft. Belvoir, VA.

5. STAMPING ON MARK – This will be stamping on the mark as described on page 26. Obviously the station designation need not be listed. The data entered here will generally be the unit that put in the station, and the date. In some cases other information, such as the elevation, may also be stamped on the mark. If so, it should be listed.

For your example, only the date–1957–and the station name are stamped on the mark.

6. AGENCY (CAST IN MARKS) – This is an abbreviation of the name of the agency actually cast in the mark as described on page For example, US Army Corps of Engineers becomes USACofE, Defense Mapping Agency – DMA, US Coast and Geodetic Survey – USC&GS, National Geodetic Survey – NGS, Bureau of Land Management – BLM, etc.

For your example use US Coast and Geodetic Survey.

7. LATITUDE – The actual latitude of the station, if known, is used here. All coordinate data will be derived from trig lists or computations of survey. Scaled or approximate latitudes should not be entered. Obviously, if the station is new and unsurveyed, this section would be left blank until the data becomes available. When the latitude is listed it must be either preceded by the correct algebraic sign [plus (+) for

stations north of the equator or minus (–) for stations south of the equator] or followed by the correct north (N) South (S) designation.

For your sample use +38° 41′ 12″.960.

8. LONGITUDE – Instructions are the same for longitude as for latitude except the designations are plus (+) or east (E) for stations east of the prime meridian and minus (–) or west (W) for stations west of the prime meridian.

For your sample use –77° 08′ 06″.755.

9. DATUM – This block is used to record the horizontal datum used to compute the station coordinates. Some examples would be "North American 1927" becomes "NAD 1927." Any time coordinates are listed with the station the "DATUM" must be correctly identified.

For your sample use North American 1927.

10. & 11. (NORTHING) (EASTING)/(EASTING)(NORTHING) – These blocks are used to list the actual grid coordinates of the station. Approximate or scaled coordinates are never used. The designation that is not listed should be blackened-out so that only the correct designation and coordinate are shown. In block 10 the (Northing) should be struck and the Easting entered. Also strike the (ft) or (m) depending on whether the coordinate is in feet (ft) or meters (m). In block 11 strike (Easting) and enter the Northing coordinate value. Northings/Eastings are long numbers and should be separated for ease of reading. This can easily be accomplished by substituting spaces for the commas. As an example, an Easting of 374,692.23 m and a Northing of 4,879,202.23 m would appear as E 374 692.23 m

N 4 879 202.23 m

For your sample use

E 314 282.439 m

N 4 283 994.627 m

12. GRID AND ZONE – This is used to define the grid system and zone designation in which the station is found. For military, the grid system will always be the Universal Transverse Mercator (UTM) with the appropriate grid zone designation. As an example "UTM 53Q." Often it will be appropriate to also list state plane coordinates. If the listed coordinates are state plane coordinates then the state must be shown. As an example, state plane coordinates on the lampert projection in the state of Tennessee could be listed as "SPTN."

For your sample use universal transverse mercator grid zone 18S.

13, 14, 15. These are the same as 10, 11, and 12. The reason they are here is to list state plane coordinates (as described above) or more commonly to record a different datum or grid zone. As an example: The coordinates may be within the 50 mi zone overlay. For more information, refer to TM 5-241-2 and TM 5-241-8.

For your sample leave this section blank.

The next section we will look at is the vertical datum block. This section will be completed only if differential levels of third order or higher have been run to establish the elevation of the station. Lower order elevations may be used but this practice is discouraged.

16. ELEVATION – This is the actual adjusted elevation of the point. Strike out (ft) or (m) as appropriate.

For your sample use 41.137 m.

17. DATUM – This section refers to the vertical datum the elevation was established in. It is usually referenced to a mean sea level that is determined by the host nation with a year of final adjustment. In the United States this is taken to Mean Sea Level 1929 (MSL 1929).

For your sample use Mean Sea Level 1929.

18. ESTABLISHED BY (AGENCY) – This is the name of the agency that established the elevation–not the station itself. Often one agency will emplace a station and survey horizontal position to it while an entirely different agency will establish the elevation.

For your sample use the Defense Mapping Agency.

19. DATE – This is the date (often only the year) that the elevation was established.

For your sample use Feb 1972.

20. ORDER – This is the actual order and class of the survey determined by the procedures and allowables outlined in the NOAA specifications. As an example:

First order class I	(First I)
Second order class II	(Sec II)
Third order	(Third)

For your sample use first order class II.

Now, let's look at what you've done. The top of your form should look like this (see Figure 2-2).

COUNTRY	TYPE OF MARK	STATION
UNITED STATES	BRASS DISK	BELVOIR (FO)
LOCALITY	STAMPING ON MARK	AGENCY (CAST IN MARK)
FORT BELVOIR VA	BELVOIR 1957	USC&GS
LATITUDE	LONGITUDE	DATUM
+ 38° 41' 12".760	-77° 08' 06".755	NAD 1927
(NORTHING)(EASTING) (FT)	(EASTING)(NORTHING) (FT)	GRID AND ZONE
314 212.439 (M)	4 283 994.647 (M)	UTM 18S
(NORTHING)(EASTING) (FT)	(EASTING)(NORTHING) (FT)	GRID AND ZONE
(M)	(M)	

ELEVATION		ELEVATION	
41.137	(FT) (M)		
DATUM			
MSL 1929			
ESTABLISHED BY AGENCY			
DMA			
DATE	ORDER		
FEB 72	FIRST		

FIGURE 2-2.

If you made any mistakes go back and review the section.

The next section of DA 1959 is the section that is most often left blank. This is unfortunate as a great deal of information can be listed here. The first two lines of this section deal with the conversion of azimuths, a procedure too involved for this lesson. Refer to TM 5-237 for more information (see Figure 2-3).

NOTE: Lat/Long could appear as:

LATITUDE	LONGITUDE	DATUM	
38° 41' 12".76 N	77° 08' 06".755 W		
(NORTHING)(EASTING) (FT)	(EASTING)(NORTHING) (FT)	GRID AND ZONE	ESTABLISHED BY AGENCY

TO OBTAIN GRID AZIMUTH ADD ° TO THE GEODETIC AZIMUTH				
TO OBTAIN GRID AZ (ADD)(SUB) ° TO THE GEODETIC AZIMUTH				
OBJECT	AZIMUTH OR DIRECTION (GEODETIC)(GRID) (MAGNETIC)	BACK AZIMUTH	GEOD DISTANCE METERS FEET	GRID DISTANCE METERS FEET
	° ' "	° ' "		
21	22	23	24	25

FIGURE 2-3.

The rest of the section deals with other survey stations visible from the station you are describing. This means a line of sight actually exists between the two stations.

21. OBJECT – This is the name or designation of the station.

For your sample list Stations Lake and Field.

22. AZIMUTH OR DIRECTION – This is the actual measured azimuth from your station to the other stations. Strike the inappropriate types. For most military projects you will list the grid azimuths and strike (geodetic)(magnetic).

For your sample list grid azimuth to Lake 225° 15' 12".5 and to Field 90° 12' 37".2.

23. BACK AZIMUTH – This is the back azimuth from your station to the other station. On the grid system, it is 180° opposite the forward azimuth. If the geodetic

azimuth is listed, it will be 180° plus or minus convergence. Again this calculation is beyond the scope of our lesson. Refer to TM 5-237.

For your sample list the grid back azimuth to stations Lake and Field.

24. GEOD. DISTANCE – This is the actual geodetic distance from your station to the distant station. Strike the (feet) as geodetic distances are usually in meters. This distance is obtained either through direct measurement (as with a microwave EDME) or through geodetic inverse computation. If this data is not available, leave this section blank. It can always be added later.

For your sample leave this section blank.

25. GRID DISTANCE – This is the computed grid distance between the stations. Grid distances are the result of measurement procedures and grid computations (either traverse or triangulation). Strike either (feet) or (meters) as appropriate. Normally for military operations on the UTM grid, this distance will be in meters.

For your sample use grid distance to Lake 3,372.236 m and to Field 1,273.984 m.

Let's check your work on this section. It should look like this: (see Figure 2-4).

TO OBTAIN	GRID AZIMUTH, ADD		TO THE GEODETIC AZIMUTH
TO OBTAIN	GRID AZ (ADD/SUB)		TO THE GEODETIC AZIMUTH
OBJECT	AZIMUTH OR DIRECTION (GEODETIC/GRID) (MAGNETIC)	BACK AZIMUTH	GEOD. DISTANCE METERS / FEET	GRID DISTANCE METERS / FEET
LAKE	225° 0' 10"S	45° 0' 10"S		3372.236
FIELD	90° 0' 31"S	270° 0' 31"S		1273.984

FIGURE 2-4.

If you have any errors go back and review the correct procedure.

The last section of administrative data will actually be done after the entire form has been completed. However, as it is basically administrative in nature, we'll cover it now. It is located on the back of DA Form 1959 (see Figure 2-5).

If a new mark is set to the exact location of a previously established but destroyed mark, the designation of the station should be identical with the original with only a new date added to its designation. If a new disk is set in the approximate location of the old station, the name should be preserved but the number "2" and a new date should be added.

(DESCRIBED) (RECOVERED) BY	
PROJECT	
DATE	FIELD BOOK

☆ U.S. Government Printing Office: 1987—201-848/60202

FIGURE 2-5.

This entire section is used to give further administrative information about the station.

26. (DESCRIBED) (RECOVERED) BY – This block is for the name of the individual doing the description. The name and rank should be legibly entered. For a new station that has not been previously described, strike the word (RECOVERED). For a previously established station for which a description exists, strike the word (DESCRIBED). This indicates the station was recovered.

For your sample Station Belvoir was recovered by you.

27. PROJECT – This will be the designation of the overall project which includes this station. Your squad leader or party chief will provide this data to you. It may be a name such as, Fort Bragg boundary traverse; or more typically a number, such as: 30/US/2TT/B/79 – Ft. Bragg NC.

For your sample use 28/US/1TT/C/84 – Ft. Belvoir VA.

28. DATE – Enter the date the description was completed. For your sample use 13 Jun 82.

29. FIELD BOOK – DA Form 1959 is not the only form that is used for recovery description. It also can be done in a field book (DA Form 4648). If data on the station is also listed on DA Form 4648 then the book number will be entered here. If all description was done on DA 1959, leave this section blank.

For your sample, all description was done on DA 1959 (see Figure 2-6)

This section of your form should look like this.

If a new mark is set in the exact location of a previously established but destroyed mark, the designation of the station should be identical with the original with only a new date added to the designation. If a new disk is set in the approximate location of the old station, the name should be preserved but the number "2" and a new date should be added.

(DESCRIBED) (RECOVERED) BY
YOUR NAME
PROJECT
28/US/1TT/C, '84 Ft. Belvoir, VA
DATE
13 Jun 82
FIELD BOOK

FIGURE 2-6.

If you have any errors on this section or any of the administrative section, review those sections now.

B. NARRATIVE DESCRIPTION

The most important information for easy recovery of a station will be the narrative description and the sketch. In reality, when writing a description, the sketch is normally completed first. However, for our purposes we will go through the narrative section first to make the sketch easier to understand.

Written narratives are so strictly formatted that one description is almost the same as another. The advantage of this structured format is that you can refer to any DA 1959 and quickly locate the information you need without reading the entire nar-

rative. As with all notes, the information entered onto DA 1959 must be neat, legible, and be a true representation. You will find with many stations the description will be very lengthy. Since a continuation is usually discouraged, you will obviously have to write small, without losing legibility.

The format we will discuss in this lesson is the correct and preferred method. Some unit's local SOP may prescribe a slightly different format. This is normally acceptable as long as all information is covered.

The narrative portion of DA 1959 can be broken down into 6 paragraphs when reference marks or azimuth marks have been emplaced, or 5 when no reference marks or azimuth marks are present. The paragraphs are:

a. Recovery Note/General Location
b. "To Reach" Statement
c. Station Site Description
d. Station Mark Description
e. Reference Mark/Azimuth Mark Description (when applicable)
f. View from Tripod Height

Again, it is important that each paragraph be listed in the same format on all cards.

1. Recovery Note/General Location

These are actually two separate bits of information but they are always listed as one paragraph. This paragraph gives the most recent status of the station and a general idea of where the station is located.

a. Recovery Note – There are only seven (7) status codes that can be listed. The following is a list of the codes and their meaning.

(1) "New Station" – This code is used for all newly established stations for which no previous information was recorded. It is not used for stations that have been reestablished.

(2) "Recovered as Described" – This code indicates that the station being recovered is a previously surveyed station that was recovered using an old description. If the old description is still accurate and up to date, the old description and sketch are transferred directly to the new DA 1959.

(3) "Recovered" – This code indicates that the station was recovered but that the description or sketch has changed and have been revised.

(4) "Not Recovered" – This code indicates that the station was not recovered. It usually will be followed by an explanation of where the station was searched for and how much effort was put forth in the search. Usually a station will not be listed as "not recovered" unless at least two teams have conducted a diligent search for the station.

(5) "Disturbed" – This code indicates that the station was found but positive evidence exists that the station is no longer in the correct place and cannot be used to extend control. A good example of this would be that a station is tilted a significant angle and no reference marks exist to "Reset" the station. Another example would be that a check angle

or check distance would not close within allowance tolerances.

(6) "Destroyed" – This code indicates that positive evidence exists that the monument has been removed or that it and its reference marks are in such poor condition, that the station cannot be reestablished. This code is never used for a station that is "Not Recovered" even though it appears the station was destroyed.

(7) "Reset" – This code indicates a monument that has been reestablished (within 1 cm) and verified, either by check angle, check distance or both. In this case, the number "2" will be stamped onto the original disk. As an example, "Blues" becomes "Blues 2".

For your sample, Station Belvoir was recovered.

b. General Location – This section provides information concerning the general location of the station. Usually a general geographic area is described first. Then some type of landmark, natural or manmade, that can be easily identified on a map and on the ground is also mentioned.

As an example: Station White is located on Ft. Campbell KY military reservation in the vicinity of the intersection of Airborne Avenue and 10th Street.

For your sample, Station Belvoir is on Fort Belvoir Virginia's South Post near the interesction of Comstock Road and Bixby Road.

2. "To Reach" Statement

Coupled with the sketch, the "To Reach" Statement will provide all information necessary to recover a station. It must be written concisely and accurately. This statement must start at some point that can be easily identified both on a map and on the ground. In many cases this will be a prominent road intersection. In rural areas it may be advisable to use a local US Post Office or other prominent government building. When possible, 8 digit grid coordinates of the start point should be included in parentheses. Typically, the "To Reach" Statement will be written as you travel from this start point to the station site. As you travel, note the odometer reading and general direction (N, S, NE etc.) of travel from the start point and at all intermediate way points. Any turns or deviations made during the travel must be mentioned by odometer reading and by direction. Any turns off the primary route should be noted by left or right with the appropriate direction (north, southwest) in parentheses. The end point of the "To Reach" Statement should be somewhere on the sketch.

As an example: To reach Station White from Gate No. 2 on Fort Campbell KY, (83462723) travel west on Campbell Blvd. 0.5 mi (0.8 km) to the intersection with Rigger Street. Turn right (north) and travel 1.0 mi (1.6 km) to the intersection with Airborne Avenue. Turn left (west) and proceed 2.4 mi (3.8 km) to the intersection of 10th Street and the vicinity of the station.

Write the "To Reach" Statement so that someone totally unfamiliar with the area will have no trouble locating the features you list.

For your sample, start your description from the intersection of US Route 1 and Belvoir Road. The grid coordinates for this intersection are 13588674. Your direction of travel is generally south. Two and half miles into your travel is the intersection of Belvoir Road and 23rd Street. At this point Belvoir Road becomes Bixby Road. No turns are made. You simply go straight on Bixby Road for 0.1 mi. to the intersection of Bixby Road and Comstock Road. The station is southwest of the intersection.

3. "Station Site Description"

This section is a description of the physical features at the site. You must identify at least three easily recognizable identifiable, permanent reference points (RPs). These RPs must also be shown on the sketch. When possible, choose features that would not be easily disturbed or destroyed and are easy to see. Avoid using trees when at all possible. Since they can be so easily destroyed, their reliability will be questioned. However, if there are no other RPs to reference, then choose large healthy trees. Additionally, list the magnetic azimuth and distance from the RP to the station. Remember, the RP should be easy to find. As an example: Station White is located at a magnetic azimuth of 40° at a distance of 28.7 m from the intersection of the center lines of Airborne Drive and 10th Street, at a magnetic azimuth of 110°, at a distance of 12 m from lamp post #24, and at a magnetic azimuth of 275° at a distance of 35 m from the southwest corner of Bldg. 237.

Notice the strict format: Located at a magnetic azimuth of _____ at a distance of ___m from _____.

For your sample in the vicinity of Station Belvoir, 35 m on an azimuth of 280° from Belvoir is the southeast corner of Bldg. 257. To east at an azimuth of 120°, 85 m away is the center line of Bixby Road. Additionally, to the north (azimuth 355°) 25 m away is the southwest corner of an asphalt lot.

4. "Mark Description"

This section is used to give a very specific physical description of the station itself. In this paragraph you must provide all information known about the station. You must completely describe the mark. This description must contain:

a. Exact description of the disk itself including: type of mark, all stamping on the mark, and agency case in the mark

b. The dimension of the surface mark

c. The composition of the mark

d. Whether the mark is set flush to the ground level, projecting above ground level, or recessed below ground level

e. Information about a subsurface mark (if one exists)

Example: Station white is a standard USACofE brass disk stamped "White, 28th Engr Bn, 1973" set in a 20 cm square concrete monument projecting 8 cm above ground. Subsurface mark was established.

For your sample Station Belvoir was established in 1957. The disk and work were done by the US Coast and Geodetic Survey. Only the name Belvoir and the date are stamped on the disk. The monument is 20 cm square and is flush with ground level. A subsurface mark was established.

5. Reference Marks/Azimuth Marks

Not all survey stations have reference or azimuth marks. If none have been established then this section would be left blank.

a. A reference mark (RM) is defined as "A permanent supplementary mark close to a survey station to which it is related by an accurately measured distance and direction." It is important NOT to confuse reference marks (RM) with reference points (RP). RPs cam be any readily identifiable feature (such as light poles, buildings, corners, etc.), whereas RMs are survey monuments. The description of an RM must contain a physical description of the mark identical to the type of description of the station itself. Additionally, the exact distance and azimuth from the station to the mark must also be listed. This azimuth and distance is usually determined while the station is being surveyed. This information is critical if the station is disturbed and must be reset. In all cases, the RMs must be shown on the sketch. As an example for Station White:

RM #1 is a standard C of E brass RM disk stamped "White RM #1 25.432 m," set in a 20 cm square monument, projecting 10 cm above ground level. It is located at an azimuth of 45° 15' 12", at a distance of 25.432 m from the station.

All RMs are described in a similar fashion. Remember, for all first and second order stations, a minimum of 2 RMs are required and 3 are preferred.

b. Azimuth marks: Azimuth marks are set as any other survey station. They are generally located at distances of 400 m or more from the station. In many cases they are for azimuth only and have no horizontal position assigned. Therefore, the only description that may be available is the one on your DA 1959 card for the main station. In those cases where the azimuth mark is part of the survey scheme and position has been established, a separate DA 1959 card will be completed on the azimuth mark. In this case a note must be made on the main station DA 1959 card that the azimuth mark has been described on a separate DA 1959. The actual description of the mark is the same as for a reference mark. That is, it will contain a physical description of the station, and the exact azimuth, but only the approximate distance from the station and the exact azimuth, but only the approximate distance from the station to the azimuth mark. Of course, if the exact distance is known it should be listed. Additionally, some general directions to the station should also be included. The sketch should reflect either a direction to the azimuth mark or its relative position should be shown. As we will see later, the sketch is not drawn to scale. As an example:

White azimuth mark is a standard C of E azimuth mark disk stamped "White AZ MK" set in a 20 cm square monument projecting 6 cm above ground level. White AZ MK is located at an azimuth of 255° 10' 12" at a distance of approximately 450 m along Airborne Avenue. Another example would be: White azimuth mark has an established position and is described on a separate description card.

Note that in this second case, White azimuth mark would appear in Section Three Block 21 of the administrative portion of the card.

For your sample Station Belvoir has 2 RM. Both are USC&GS disks stamped "Belvoir #1 1957 25.132" and "Belvoir #2 1957, 24.236." Both are set in 15 cm square monuments projecting 10 cm above ground. The azimuths to these RMs are: Belvoir #1 – 96° 02' 12."3
Belvoir #2 – 287° 02' 56."8.

Belvoir azimuth mark is a standard USC&GS azimuth mark disk stamped "Belvoir AZ MK 1957." The dimensions for the azimuth are the same as for the RMs. The azimuth to the station is 12° 15' 45."3 and the distance is 375.235 m.

6. View From Tripod Height.

This section of the card is very important as it helps in determining the usefulness of a station for future surveys. It provides a panoramic description of terrain, cultural features and vegetation at tripod height over the station mark. A station in a built-up area without lines of sight would not be very useable.

Once again, the format for this section is set. To obtain the information for this section the surveyor uses a map and compass. The compass is used to determine azimuths and the map to determine approximate distances. To do this, stand on the station and use the compass to divide the horizon into sections based on visibility. While you're dividing these avenues of visibility, use the map to determine the approximate distance to obstructions. As an example: View from tripod height is limited to 200 m in arc from 0° to 25°, blocked by Bldg. 237 from 26° to 90°, limited to 400 m from 91° to 140°, unlimited from 14° to 275°, restricted to 300 m from 276° – 360°.

For your sample at Station Belvoir, the view from tripod height is limited to less than 200 m in all directions, except in an arc from 0° to 35° where the view is limited to 600 m and from 180° to 210° where the view is limited to 300 m.

Before we go on, let's take a look at what you have done. Check your sample card. It should be very similar to Figure 2-7.

C. SKETCH

Normally, the sketch would be one of the first things you do while you are at the station site. Surveyors are not draftsmen; however, using a straightedge and a little care you should be able to render a concise, clear, useable sketch. Bear in mind,

COUNTRY	TYPE OF MARK	STATION	
United States	Brass Disk	Belvoir	
LOCALITY	STAMPING ON MARK	AGENCY (CAST IN MARK)	ELEVATION (FT) (M)
Ft. Belvoir, VA	1957	USC&GS	41.137
LATITUDE	LONGITUDE	DATUM	DATUM
+ 38° 41' 12".960	−77° 08' 06.755	NAD 1927	MSL 1929
~~(NORTHING)~~(EASTING) (FT) (M)	~~(EASTING)~~(NORTHING) (FT) (M)	GRID AND ZONE	CHART SHEET BY (AGENCY)
314 282.439	4 283 994.627	UTM 18S	DMA
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	DATE / ORDER
			Feb 72 / First II

TO OBTAIN GRID AZIMUTH ADD ° ' " TO THE GEODETIC AZIMUTH

TO OBTAIN GRID AZ (ADD)(SUB) ° ' " TO THE GEODETIC AZIMUTH

OBJECT	AZIMUTH OR DIRECTION ~~(GEODETIC)(GRID)~~ (MAGNETIC)	BACK AZIMUTH	GEOD. DISTANCE (METERS) (FEET)	GRID DISTANCE (METERS) (FEET)
Lake	225° 15' 12".5	45° 15' 12".5		3 472.236
Field	90 12 37.2	270 12 37.2		1 273.984
Belvoir AZ MK	12 15 45.3	192 15 45.3		375.236

Recovered: Station Belvoir is located on the South Post of Fort Belvoir VA in the vicinity of the intersection of Bixby Road and Comstock Road.

To reach the station from the intersection of US Route 1 and Belvoir Road (Grid Ref. 1358 8674), travel south on Belvoir Road 2.5 miles (4.0 km) to the intersection with 23rd Street. At this point Belvoir Road becomes Bixby Road. Proceed straight (south) on Bixby 0.1 mi. (0.2 km) to the intersection with Comstock Road. Station is southwest of this intersection.

Station Belvoir is located at a magnetic azimuth of 100° for a distance of 35 m from the southeast corner of Bldg. 257 at an azimuth of 265° at a distance of 85 m from the centerline of Bixby Road, and at an azimuth of 175° at a distance of 25 m from the southwest corner of an asphalt lot.

Station Belvoir is a standard USC&GS brass disk stamped "Belvoir 1957" set in a 20 cm square monument set flush with the ground.

RM #1 is a USC&GS RM stamped "Belvoir RM #1 1957 25.132" set in a 15 cm square monument projecting 10 cm above ground level. It is located at an azimuth of 96° 15' 12".3 at a distance of 25.132 m from the station.

RM #2 is a USCG&GS RM stamped "Belvoir RM #2 1957 24.236" set in a 15 cm square monument projecting 10 cm above ground level. It is located at a grid azimuth of 187° 02' 56".8, at a distance of 24.236 m from the station.

Belvoir azimuth mark is located at an azimuth of 12° 15' 45."3 at a distance of 375.236 m from the station Belvoir azimuth mark 1175 position and is described on a separate DA 1959. View from tripod height is limited to 600 m in an arc
from 0° to 35°, 200 m in arc from 36° to 179°
300 m in an arc from 180° to 210° and 200 m
from 211° to 0°.

SKETCH

DA FORM 1 OCT 64 1959 REPLACES DA FORMS 1959 AND 1960, 1 FEB 57, WHICH ARE OBSOLETE

DESCRIPTION OR RECOVERY OF HORIZONTAL CONTROL STATION
For use of this form, see TM 5-237; the proponent agency is TRADOC

FIGURE 2-7.

the sketch is not drawn to scale but relative horizontal position must be correct. Additionally, a north arrow is preprinted on the form and must be accurate.

Often it is better to draw the initial sketch on a blank piece of paper. This allows you to work on a much larger scale and to make corrections as you see fit. The final sketch goes into a fairly small section of the card and it is best to work out details on a large format first. This is particularly true for an inexperienced person.

To start the sketch, it is generally practical to sit down on the station, orient your drawing to north, and place a standard station symbol in the center of the page. Look around and start sketching in major features that are in the local area. Obviously, it is difficult to visualize an area merely from a written description as we are doing here. But you sometimes may need to use your imagination, so this actually can be a very good exercise. Always keep in mind that you are preparing a sketch, not a map. As a minimum your sketch should include:

1. The station symbolized by station designation.
2. North Arrow (preprinted on DA 1959)
3. All reference marks
4. All other survey stations in the immediate vicinity
5. All reference points listed in the narrative
6. Azimuths and distances from RPs to station
7. The point where the "To Reach" Statement stops
8. Any prominent cultural features that add clarity and definition to the areas.
9. In the absence of other RPs, you may have to use contour lines, ditch lines, etc. This is particularly true in areas where only relief can be used to define a point: for example, a drop zone without trees or other features.
10. Adequate coverage of the area: Unfortunately what is "adequate" is a judgment call. But these are some questions you can ask yourself to help in your decision:

    Provided the "To Reach" is good, does my sketch show enough detail to easily find this station several years from now?

    - Are my RPs truly prominent and permanent?
    - Have I included other prominent, permanent manmade features?
    - If I have used only relief/drainage features, are they stable enough to ensure some permanency?

Hopefully, the answers to these and other questions concerning the features you have selected are 'yes'. Never take your sketches lightly. They are a very important part of the historic documentation of survey stations.

It has often been said that one picture is worth a thousand words. This overused

expression was never more appropriate than when considering survey site descriptions. Let's look at the sketch of the area of Station White and see if you can visualize the area (Figure 2-8).

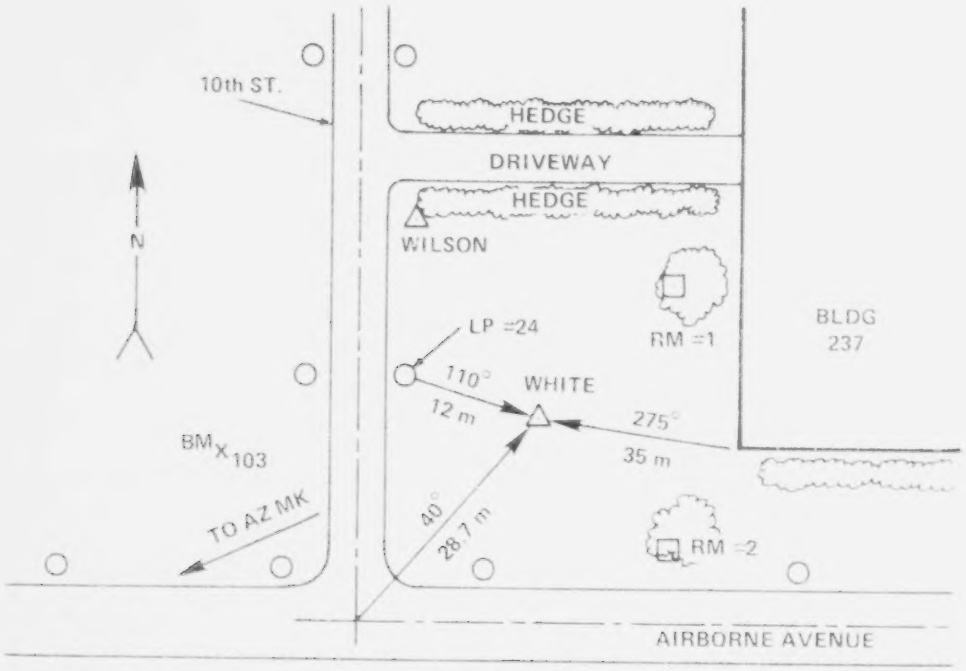


FIGURE 2-8.

Does it show the station?
Does it have a north arrow?
Does it show the correct position of the RMs?
Are other survey stations shown and correctly symbolized?
Are the RPs mentioned in the narrative shown?
Are the azimuths and distances from the RPs to the station shown?
Is the point where the "To Reach" Statement stops shown on the sketch?
Are prominent cultural features that add clarity and definition to the area shown?
Is the area covered by the sketch adequate?
Could you find this station?

If the answer to each question is 'yes', then we have a good sketch.

If you feel you understand the basics of sketching a survey station site, try your skill with the information from the narrative of Station BELVOIR.

If you're still not sure, review this section and then step outside and sketch the area

outside the door. Have your trainer review and critique your sketch, then try to sketch Station Belvoir (Figure 2-9).

FIGURE 2-9.

If your sketch contains all the information and the relative positions are correct then you're getting the idea. Now look at the finished sketch and look at the extra details that have been added (Figure 2-10). Obviously you could not get this additional information without visiting the station site. That's why it is so important that your sketch be correct and complete before you leave the station. If you have too much information, it can be edited out later. Remember, no surveyor ever went back to a station because he collected too much information (Figure 2-11).

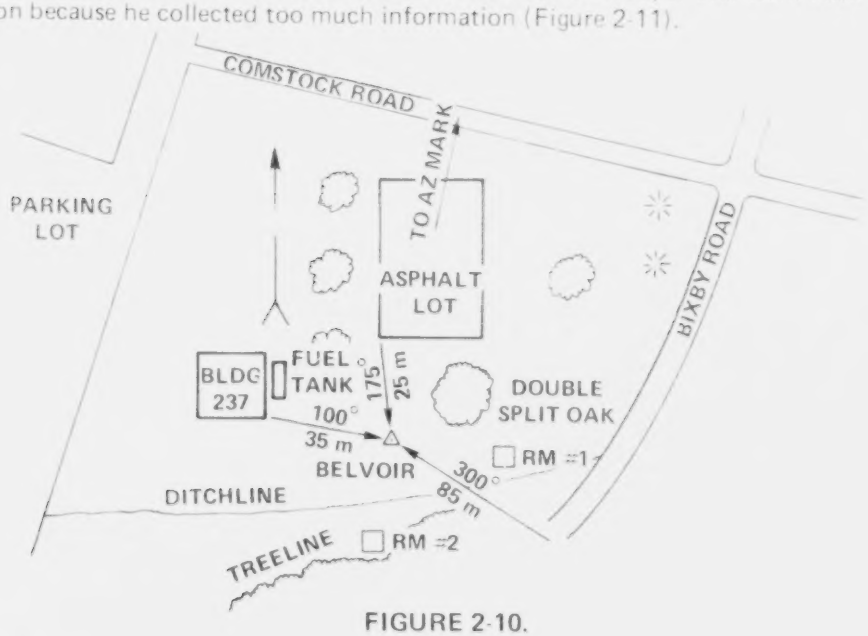


FIGURE 2-10.

COUNTRY	TYPE OF MARK	STATION	
United States	Brass Disk	Belvoir	
LOCALITY	STAMPING ON MARK	AGENCY (CAST IN MARK)	ELEVATION (FT) (M)
Ft. Belvoir, VA	1957	USC&GS	41.137
LATITUDE	LONGITUDE	DATUM	ATUM
+38° 41' 12".960	−77° 08' 06.755	NAD 1927	MSL 1929
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	ESTABLISHED BY (AGENCY)
314 282 439	4 283 994.627	UTM 18S	DMA
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	DATE / ORDER
			Feb 72 / First II

TO OBTAIN GRID AZIMUTH, ADD ° TO THE GEODETIC AZIMUTH

TO OBTAIN GRID AZ. (ADD)(SUB) ° TO THE GEODETIC AZIMUTH

OBJECT	AZIMUTH OR DIRECTION (GEODETIC)(GRID) (MAGNETIC)	BACK AZIMUTH	GEOD. DISTANCE (METERS) FEET	GRID DISTANCE (METERS) (FEET)
Lake	225° 15' 12".5	45° 15' 12".5		3 472.236
Field	90 12 37.2	270 12 37.2		1 273.984
Belvoir AZ MK	12 15 45.3	192 15 45.3		375.236

Recovered: Station Belvoir is located on the South Post of Fort Belvoir VA in the vicinity of the intersection of Bixby Road and Comstock Road.

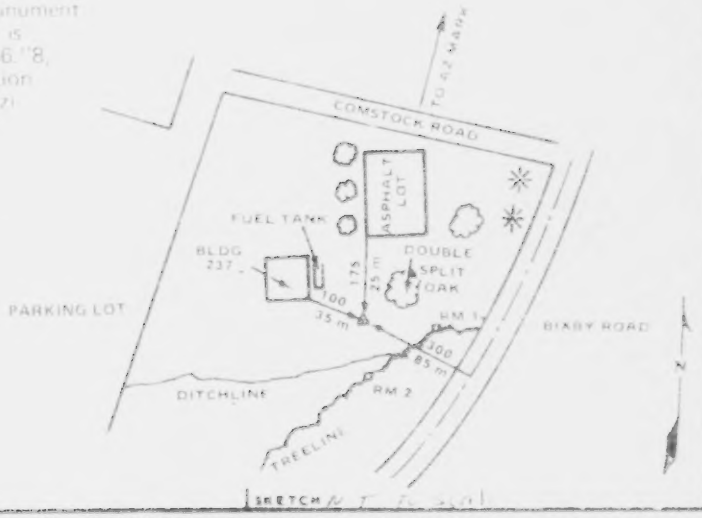
To reach the station from the intersection of US Route 1 and Belvoir Road (Grid Ref. 1358 8674), travel south on Belvoir Road 2.5 miles (4.0 km) to the intersection with 23rd Street. At this point Belvoir Road becomes Bixby Road. Proceed straight (south) on Bixby 0.1 mi. (0.2 km) to the intersection with Comstock Road. Station is southwest of this intersection.

Station Belvoir is located at a magnetic azimuth of 100° for a distance of 35 m from the southeast corner of Bldg. 257 at an azimuth of 265° at a distance of 85 m from the centerline of Bixby Road, and at an azimuth of 175° at a distance of 25 m from the southwest corner of an asphalt lot.

Station Belvoir is a standard USC&GS brass disk stamped "Belvoir 1957" set in a 20 cm square monument set flush with the ground.

RM =1 is a USC&GS RM stamped "Belvoir RM =1 1957 25.132" set in a 15 cm square monument projecting 10 cm above ground level. It is located at an azimuth of 96° 15' 12".3 at a distance of 25.132 m from the station.

RM=2 is a USCG&GS stamped "Belvoir RM=2 1957 24.236" set in a 15 cm square monument projecting 10 cm above ground level. It is located at a grid azimuth of 187° 02' 56."8, at a distance of 24.236 m from the station. Belvoir azimuth mark is located at an azimuth of 12° 15' 45."3 at a distance of 375.236 from the station Belvoir azimuth mark 1175 position and is described on a separate DA 1959. View from tripod height is limited to 600 m in an arc from 36° to 179° 300 m in an arc from 180° to 210° and 200 m from 211° to 0°.



DA FORM 1 OCT 64 1959 REPLACES DA FORMS 1838 AND 1880, 1 FEB 57, WHICH ARE OBSOLETE

DESCRIPTION OR RECOVERY OF HORIZONTAL CONTROL STATION

For use of this form, see TM 5-237; the proponent agency is TRADOC

FIGURE 2-11

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE
ROCKVILLE, MD 20852

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, $300

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 1100 ROCKVILLE, MD

POSTAGE WILL BE PAID BY
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

National Geodetic Information Center, N/CG17
National Ocean Service, NOAA
Rockville, MD 20852

NOAA FORM 76-91
(10-83)

REPORT ON CONDITION OF SURVEY MARK

Form Approved OMB No. 0648-0006
Approval Expires April 30, 1986

SSN ____ DRC CODE R QUAD--N _____ QSN- _____

STATION NAME- _____

STATE CODE/COUNTY- ___/_____ YEAR ESTABLISHED- _____

Organization's Mark _____

RECOVERY BY: Name _____ YEAR RECOVERED _____

Organization _____

Address _____

Give a report on the thoroughness of the search in case a mark was not recovered; suggested changes in description; need for repairing or replacing the mark; or other pertinent facts. Record letters and numbers found stamped on top surface of each mark.

Mark stamped Condition

If additional forms are needed indicate number required _____

This report is authorized by law (Title 33 USC Section 883a). While you are not required to respond your cooperation is needed to make the results of this report comprehensive, accurate, and timely.

FIGURE 2-12

The last function you should perform is to complete NOAA Form 76-91 (Figure 2-12). This simple form allows the National Geodetic Survey to update its trig lists. It is recommended that this form be filled out on all third order, class I stations. For stations on the National Network it must be submitted. Blank copies of this form can be obtained by a written request to the address shown in Figure 2-12.

If you feel you need more practice, ask your supervisor to assign you a station in the local area. Work up a complete DA 1959 and have him critique it for you.

You have now completed this lesson. Take the post test to see if you have mastered this lesson.

PRACTICE EXERCISE 2

Use the following information to complete the heading on a DA Form 1959.

In August 1983, the 28th Engineer Company established station FLAG as part of a third order, class one traverse. The adjusted UTM grid coordinates are northing 4 484 762.673 m, easing 314 876.538 m, in UTM grid zone 18S. Elevation, 148.727m, was established by third order leveling during the traverse operation. Station is marked by a 105mm shell casing set in concrete, stamped "FLAG 1983". Geographic coordinates have not been computed.

COUNTRY	TYPE OF MARK	STATION	
LOCALITY	STAMPING ON MARK	AGENCY (CAST IN MARK)	ELEVATION (FT) (M)
LATITUDE	LONGITUDE	DATUM	DATUM
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	ESTABLISHED BY (AGENCY)
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	DATE / ORDER

TO OBTAIN GRID AZIMUTH, ADD ° ' " TO THE GEODETIC AZIMUTH

TO OBTAIN GRID AZ (ADD)(SUB) ° ' " TO THE GEODETIC AZIMUTH

OBJECT	AZIMUTH OR DIRECTION (GEODETIC)(GRID) (MAGNETIC) ° ' "	BACK AZIMUTH ° ' "	GEOD DISTANCE (METERS) FEET)	GRID DISTANCE (METERS) FEET)

ANSWERS FOR PRACTICE EXERCISE 2

Check your DA Form 1959 against the completed form heading below. Make necessary corrections.

COUNTRY	TYPE OF MARK 155mm SHELL CASE	STATION FLAG	
LOCALITY	STAMPING ON MARK FLAG 1983	AGENCY (CAST IN MARKS)	ELEVATION 148.727 (M)
LATITUDE	LONGITUDE	DATUM	DATUM
(EASTING) (FT) (M) 314876.538 (M)	(NORTHING) (FT) (M) 4484762.673 (M)	GRID AND ZONE UTM 18S	ESTABLISHED BY (AGENCY) 28th Engr Co
(NORTHING) (EASTING) (FT) (M)	(EASTING) (NORTHING) (FT) (M)	GRID AND ZONE	DATE / ORDER Aug 83 / 3rd

TO OBTAIN GRID AZIMUTH ADD TO THE GEODETIC AZIMUTH

TO OBTAIN GRID AZ (ADD) (SUB) TO THE GEODETIC AZIMUTH

OBJECT	AZIMUTH OR DIRECTION (GEODETIC) (GRID) (MAGNETIC)	BACK AZIMUTH	GEOD DISTANCE (METERS) (FEET)	GRID DISTANCE (METERS) (FEET)
	° ' "	° ' "		

Turn the page and take the Self-evaluation Exercise to check your understanding of this lesson.

SELF EVALUATION

1. When reference marks are emplaced, which direction should the arrow point?
   a. Along the line of traverse
   b. At the station mark
   c. To magnetic north
   d. To the other reference marks

2. An old description calls for a monument to be on a granite outcrop on a ridge top. At the described location only an empty star drill hole can be found and no reference marks were emplaced. Which recovery code would you list on DA Form 1959?
   a. Not recovered
   b. Disturbed
   c. Reset
   d. Destroyed

3. How many cubic feet of dry concrete material (cement, sand and aggregate) would be required to fill a hole 2 ft deep and 18 in in diameter?
   a. 3.5
   b. 5.3
   c. 7.1
   d. 14.1

4. How many reference marks should be emplaced for a first order class I station?
   a. 3 required 4 preferred
   b. 2 required 3 preferred
   c. 2 required 2 preferred
   d. 1 required 2 preferred

5. Use the following information to complete the heading on a DA Form 1959. Triangulation station HILL was established by the 975th Engineer Detachment in April, 1984. The station is located on Taylor Barracks in Manheim, West Germany. Second order class two control was established by traverse. Geographic coordinates are, latitude 46° 17' 26.815", longitude 06° 47' 31.782". Grid coordinates have not been computed. Elevation was established by the 36th Engineer Company using 3rd order differential leveling.. The adjusted elevation is 97.64 meters. The station is marked by a brass disk stamped "HILL 1984".

COUNTRY	TYPE OF MARK	STATION	
LOCALITY	STAMPING ON MARK	AGENCY (CAST IN MARK)	ELEVATION (FT) (M)
LATITUDE	LONGITUDE	DATUM	DATUM
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	ESTABLISHED BY (AGENCY)
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	DATE / ORDER

ANSWERS TO SELF-EVALUATION

1. b
2. d
3. b
4. b
5. Check your DA Form 1959 against Figure SE 1, and make necessary corrections.

COUNTRY	TYPE OF MARK	STATION	
WEST GERMANY	BRASS DISK	HILL	
LOCALITY	STAMPING ON MARK	AGENCY (CAST IN MARK)	ELEVATION (FT) (M)
WAHLHEIM	HILL 1984	975th ENGR DET	97.64
LATITUDE	LONGITUDE	DATUM	DATUM
+ 17° 26' 815	+006° 47' 31" 782		NW. AMSTERDAM
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	ESTABLISHED BY (AGENCY)
			36th ENGR Co.
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	DATE / ORDER
			1984 / 3RD

FIGURE SE-1

If you did not do well on the self-evaluation test, review the lesson before taking the post test.

1. C
2. D
3. B
4. A
5. D
6. C
7. C
8. C
9. B
10. D
11 - 19. The heading should be completed as shown below.

COUNTRY	TYPE OF MARK	STATION	
UNITED STATES	BRASS DISK	CAMPBELL	
LOCALITY	STAMPING ON MARK	AGENCY (CAST IN MARK)	ELEVATION (FT) (M)
FT CAMPBELL KY	CAMPBELL 1974	USCGS	
LATITUDE	LONGITUDE	DATUM	DATUM
		NAD 1927	
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	ESTABLISHED BY (AGENCY)
3,550,823	4 032 526.37	UTM 16S	
(NORTHING)(EASTING) (FT) (M)	(EASTING)(NORTHING) (FT) (M)	GRID AND ZONE	DATE / ORDER

TO OBTAIN	GRID AZIMUTH ADD	TO THE GEODETIC AZIMUTH
TO OBTAIN	GRID AZ (ADD|SUB)	TO THE GEODETIC AZIMUTH

OBJECT	AZIMUTH OR DIRECTION (GEODETIC|GRID) (MAGNETIC)	BACK AZIMUTH	GEOD DISTANCE (METERS) (FEET)	GRID DISTANCE (METERS) (FEET)

20. B
21. D
22. A
23. B
24. A
25. A

PRETEST/POSTTEST ANSWER KEY